CITY OF GUSTINE

YEAR 2002
WATER MASTER PLAN

ADOPTED

MARCH 3, 2003

STODDARD & ASSOCIATES

CONSULTING CIVIL ENGINEERS
& LAND SURVEYORS

FEBRUARY 2003

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I. INTRODUCTION

The City of Gustine (City) is a small rural community located in the western portion of Merced County at the crossroads of State Highways 140 and 33. The City's municipal water supply is derived from the underlying groundwater using four deep wells. In February 2002, the City adopted a General Plan (City of Gustine, 2002) to guide the growth of the City over the next 20 years. The focus of this master plan is to define the water supply, storage and distribution facilities required to provide a high level of water service for buildout of the General Plan.

The evaluation of water supply includes consideration of groundwater conditions and conversion to surface water as appropriate. The number, location and configuration of the proposed deep well installations depends upon the assessment of the probability of developing groundwater meeting the drinking water standards and the location of the water meeting the standards relative to the service area. Daily water demands and peak water demands during the day can be met with a combination of deep wells and water stored in surface mounted storage tanks. The number and locations of the storage tanks follow siting of the production wells. Upon completion of the plan for these facilities, the required distribution network is configured to deliver both peak daily flows to the service area as well as water for firefighting purposes (fire flows). The criteria for selection of water supply, storage and distribution components are presented in this study.

A. AUTHORIZATION

Stoddard & Associates has been authorized by the City to perform this water master plan pursuant to Professional Services Work Order, Supplemental Agreement

No. 1-2001 dated January 21, 2002, to Agreement for Engineering Services dated July 17, 2001.

II. SCOPE OF STUDY

A systematic process is followed to define the water supply and distribution improvements needed to service the City at full General Plan buildout (Project Area). The scope of study for this project is comprised of several sections. The first section defines the Project Area, develops water demands for the various land use types, and projects future water use. In this section, the fire flow demands for the various land use types are also specified.

The second section evaluates the availability of groundwater based on a recent hydrogeologic study and available test well data. The recommended plan for development of additional wells or alternate surface water supply, if necessary to meet the water demand for buildout of the Project Area based on groundwater availability, is the result of this analysis.

Once the probable locations of water supply facilities are identified, the pipeline network system and required water storage and pumping to meet the projected demands can be defined, which is the focus of the third section. Development of the pipeline, storage and pumping facilities needs is accomplished by first updating, testing and verifying the computer model of the existing water system. The probable future water supply scenario is added to the model to set the stage for modeling various pumping and distribution schemes to determine the most cost effective method of water distribution to the Project Area. Once the water supply, storage, and distribution system elements are defined for the Project Area, appropriate cost estimates are developed to provide planning level cost estimates for the required facilities.

III. COMMUNITY WATER DEMAND

There are several components and characteristics of a community's water demand which must be considered in developing water supply facilities. The demand assessment begins with an estimate of the average amount of water which is expected to be consumed. This quantity is specified in terms of the number of million gallons to be consumed daily and in gallons per minute (gpm) on the average day needed to meet the Project Area demand. To this basic demand figure, various factors are applied to project the maximum day demand and peak instantaneous demand (peak hour flow) for the purposes of sizing pipelines, storage and pumping facilities. Another important component of water demand, relatively large in smaller communities, is the amount of water flow needed for fire protection.

In the following paragraphs, the unit water demand amounts are developed for each category of land use in the Project Area for water master planning purposes. The unit water demand figures are then applied to the undeveloped area within the Project Area to determine the expected increase in water demand. The total community demand equals the existing demand plus the projected increase for the Project Area.

A. DEVELOPMENT OF UNIT WATER DEMANDS

1. Residential Use

A unit average consumptive use rate of 460 gallons per residential unit per day, representing low density single family residential use and planned unit development use within the community, is the residential unit demand used in this study. Both land uses will have housing densities in the one to six dwelling units per acre range. No separate unit water demand is quantified for high density residential land use since the undeveloped area contains no proposed high density land use. This unit demand figure is comparable with other unit demand figures for similar communities and represents a reasonable estimate of future single family residential demand, assuming: conventional sized lots, the use of water conservation devices, such as low flow toilets and shower heads, and a community with metered water deliveries and practicing voluntary water conservation.

This unit demand figure represents the average annual single-family residential use which is adjusted by appropriate peaking factors as described.

Using an average housing density of 4.5 units per acre, the residential water duty flow rate is 1.44 gpm/acre average daily flow.

2. Commercial and Industrial Use

Water used by commercial and industrial users can vary substantially depending on the actual nature of the business. For distribution system planning purposes, average typical unit water demands are normally utilized. In this study, an average unit water demand for both commercial and industrial uses is selected at 2,500 gallons per day per acre or 1.74 gpm/acre average daily flow.

3. Park and Greenway Use

The park and greenway water demand component is calculated at 4.5 acre-feet per acre per year or 2.79 gpm/acre average daily flow.

B. WATER DEMAND PEAKING FACTORS

The previous section presents the anticipated unit water demands for the expansion of the community based on average daily flow. Water supply capacity must equal or exceed the maximum day demand. Pipeline and pump station facilities must be able to supply the peak hour flow. To develop appropriate peaking factors, water usage over the three-year period of 1998 through 2000 was reviewed and peaking factors determined as shown in Table III-1. The factors recommended to be used were selected based on the water use data and typical demand factors for similar communities. The City does not collect the data needed to determine peak hour flow factors, so the peaking factor used to arrive at the peak hour demand is based on similar communities. The data indicate a maximum day to average day peaking factor average of about 2.0. The use of 2.0 is also very reasonable for the peak hour demand to maximum day demand factor. A 2.0 factor to convert average day to maximum day and a 2.0 factor to convert maximum day to peak hour are adopted to size the future backbone water supply and distribution system for the Project Area.

Table III-1

PEAKING FACTOR CALCULATION

Year	Water Use (MG)	Maximum Day Use (MGD)	Max Day To Average Day Factor	Peak Hour To Max Day Factor
1998	336.9	1.79	1.94	N/A
1999	378.9	1.85	1.78	N/A
2000	399.7	1.76	1.61	N/A
Use			**2.0**	**2.0**

C. COMMUNITY WATER DEMAND

The land use data, unit water demand figures, and peaking factors come together to create the profile of the expected Project Area water demand. The Project Area water demand equals the projected demand for the undeveloped area plus the existing City water demand. A summary of these data is presented in Table III-2. The Project Area is shown on Figure 1, which depicts the various land areas to be developed. The estimated average water demand for the undeveloped area is 2.33 million gallons per day (MGD). When added to the existing community use, which includes allowance for infill, the total water demand of the community is expected to be 3.77 MGD or about 4,200 acre-feet annually (AFA). The appropriate number of new wells, storage facilities, and booster stations or other water supply sources to meet this water demand are determined by evaluating the various methods and choosing the best combination of facilities to supply water in accordance with specified performance criteria.

Table III-2

COMMUNITY WATER DEMAND SUMMARY

Land Use	Area Acres	Unit Water Demand gpd/ac	gpm/ac	Area Demand gpd	gpm
Undeveloped Area					
Residential	580	2,070	1.44	1,200,600	834
Commercial	82	2,500	1.74	205,000	142
Industrial	300	2,500	1.74	750,000	521
Parks	44	4,017	2.79	176,748	122
Subtotal	**1,006**			**2,332,348**	**1,619**
Existing City Demand[1/]				1,440,000	1,000
Total Community Demand				**3,772,348**	**2,619**

[1/] 150 gpm allowance for infill included

IV. WATER SUPPLY

A. EXISTING WATER SUPPLY

The City of Gustine currently utilizes the underlying groundwater to meet 100% of the City water demand. In 2001, the City utilized four wells located at various locations throughout the City to pump 1,371 acre-feet. Well No. 1 was used only in April and June. The nominal pumping rate of each well is shown in Table IV-1.

Table IV-1

NOMINAL WELL CAPACITIES

Well No.	Flowrate (gpm)
1	1,100
4	800
5	1,700
6	800
Total	**4,400**

Prior groundwater pumping and metered deliveries for municipal water supply over a six-month period are shown on Table IV-2. Prior to August 2001, data on the total metered deliveries were not available. The "% Unbilled" is the difference between the water produced by each well and the metered deliveries. The difference occurs due to unmetered connections, leakage, fire flows, line flushing, and metering inaccuracies.

The difference between the water production data and the metered delivery data ranges from a minimum of 16% to a maximum of 39% averaging 28%. The City is refining its accounting system which now has the ability to totalize metered deliveries. As part of water operations, the fate of the unmetered supply should be evaluated to reduce losses and increase revenue.

Table IV-2

RECENT MONTHLY PUMPAGE FROM CITY WELLS

Month		Well Production Acre-Feet	Metered Delivery Acre Feet	% Unbilled
August	2001	176	107	39
September	2001	152	108	29
October	2001	117	82	30
November	2001	76	64	16
December	2001	74	49	34
January	2002	70	56	20

B. WELL WATER QUALITY

Even though the City is very careful in selection of depth intervals tapped by each well, the quality of the water developed by each of the wells varies depending on well location. The water quality of each well, defined by the primary constituents of concern, is shown in Table IV-3. Constituents exceeding the specified maximum containment levels (MCLs) set forth in the Domestic Water Quality Standards (California Code of Regulations, Title 22, Division 4, Chapter 15 "Domestic Water Quality and Monitoring") are highlighted in the table. Primary MCLs are established to protect public health. Primary MCLs are not exceeded in the City wells. Secondary MCLs are set based on consumer acceptability of the supply; secondary constituents may adversely affect taste, odor or appearance of the drinking water. While the recommended limits can be exceeded based on water availability, the upper limits of secondary standards can only be exceeded temporarily until alternate sources come on line. New connections to the water system may not be allowed unless adequate progress is demonstrated toward providing water of improved mineral quality.

The major water quality problems in the City's wells are high concentrations of salinity as measured by total dissolved solids (TDS) and high concentrations of nitrates, chlorides and sulfates. Based on a recent study of groundwater conditions discussed in the following section, groundwater meeting the secondary drinking water MCLs appears to be more abundant to the west and southwest of the City.

The existing wells have other deficiencies. Well No. 1 pumps a large amount of sand into the distribution system and has nitrate levels approaching the primary MCL. It is currently used only during high water demand periods. Well No. 4 also produces sand but the sand separator performs satisfactorily. The well is used in everyday operations. Well No. 5 developed water quality problems, identified as this study was being performed, as discussed in the next section.

Table IV-3

WATER QUALITY IN EXISTING WELLS
SUMMARY OF PRIMARY CONSTITUENTS OF CONCERN

						MAXIMUM CONTAMINATE LEVEL (MCL)			
						PRIMARY	SECONDARY		
CONSTITUENTS	1	4	5	5R[1]	6		REC.	UPPER	SHORT TERM
GENERAL MINERALS									
Test Date	1-16-02	1-16-02	1-29-99	12-13-01	2-22-99				
HARDNESS mg/L	450	280	124		340	N/A			
CA mg/L	110	72	25	67	80	N/A			
MG mg/L	43	24	15		34	N/A			
NA mg/L	92	65	200		89	N/A			
HCO3 mg/L	240	200	250	180	265	N/A			
SO4 mg/L	140	130	145	240	106		250	500	600
CL mg/L	190	58	133	440	119		250	500	600
NO3 mg/L	42	21	14	35	32	45			
E.C. uS/cm	1300	820	1110	2000	1000		900	1600	2200
TDS mg/L	710	500	673	1200	617		500	1000	1500
AS ug/L	3	3	3.8		2	50			
CR ug/L	10	9	<10		10	50			
FE ug/L	20	80	<50		50		N/A	300	N/A
MN ug/L	10	10	28		10		N/A	50	N/A
GROSS ALPHA									
Test Date	9-27-95	9-27-95	2-5-99		2-18-99				
G. ALPHA pC/l	ND	ND	2		4	5[2]			

[1] Retest of certain constituents, December 13, 2001.
[2] Requires additional testing for Uranium and/or Radium
Shaded values equal or exceed secondary recommended limits.
ND = Non Detected

C. WATER SUPPLY SOURCES FOR PROJECT AREA BUILDOUT

In 2001, the City, in a joint effort with Central California Irrigation District, began an evaluation of hydrogeologic conditions in the vicinity of the City of Gustine. A draft report summarizing this work was completed in September of 2001, (Schmidt, 2001).

The hydrogeologic evaluation concluded that the area most favorable for development of groundwater meeting the Domestic Water Quality Standards was the area to the west and southwest of the City. The east and northeast portions of the City were to be avoided. It was estimated that production could double (to 2,400 acre-feet) without serious water quality problems. It was concluded that under present conditions, consideration of artificial recharge of the aquifer is not necessary since there is no indication of groundwater overdraft in the area. It noted, however, that urbanization could shift the water resource balance by eliminating surface water inflows which are utilized to irrigate the lands prior to development which provide a component of recharge through deep percolation of a portion of the irrigation water. The report does not distinguish between the availability of water in the unconfined aquifer above the Corcoran Clay and that in the confined aquifer below. Since the report presents the water quality data on Well No. 5 prior to its deterioration, it is presumed that the conclusions regarding groundwater availability consider water meeting the Domestic Water Quality Standards in both the unconfined and the confined aquifers.

Substantially, all of the groundwater pumping which takes place in the vicinity draws water from the unconfined aquifer. At the time the hydrogeologic study was performed, the latest available water quality data were obtained from the testing done in early 1999. Water quality test results reviewed as part of this study revealed December 2001 test results which showed substantial water quality deterioration in Well No. 5. The salinity of the well water, measured by TDS and electroconductivity, now exceeds the secondary standard upper limit. A recent retest on Well No. 5 and a subsequent retest have confirmed the exceedance; therefore, pursuant to the Domestic Water Quality Standards, Well No. 5 is no longer suitable as a long term City water supply well.

Other data on the quality of water in the confined aquifer include several aquifer samplings which were conducted in 1998 and 1999. In a test hole identified as Borrelli Test Hole, TH-3, drilled near the corner of Jensen Road and Lucerne Avenue, the results of the water sampling and testing program indicated that the water in the confined aquifer at this location did not meet the Domestic Water Quality Standards. A subsequent test hole also identified as the Borrelli Ranch Test Well was drilled in October 1999. No driller's log or electric log were available for this test well. At this location, three deep aquifer zones were sampled and tested. The testing showed the salinity as measured by TDS ranged from 1000 mg/l in the 290 to 308 foot zone to 950 mg/l in the 400 to 418 foot zone demonstrating the water in the confined aquifer at this location to be at or near the upper limit of 1000 mg/l.

With these aquifer sampling data collected in the Borrelli Ranch area and the recent deterioration of water quality in Well No. 5, there is no demonstration that potable water to meet the City's water demand is available in the deeper aquifers below the Corcoran Clay. Further reconnaissance was performed to better understand the water quality in the confined aquifer. Land-O-Lakes operates an industrial well to serve their industrial water needs. This well is a composite well with perforations in the 210 to 230 foot range in the unconfined aquifer and between 355 and 410 feet in the confined aquifer. Avoset Foods operates a deep well that pumps solely from the unconfined aquifer with perforations in the 174 to 254 foot range. It would be expected that the water entering the Land-O-Lakes well from the unconfined zone would have salinity levels in the same range as the Avoset Foods well. Field electroconductivities were measured from water drawn from the Land-O-Lakes well, the Avoset Foods well, and Well No. 5. The results are shown on the following table:

Table IV-4

FIELD ELECTROCONDUCTIVITY FOR WELLS TAPPING THE CONFINED AQUIFER

Well I.D.	Electroconductivity (micromhos per centimeter)	Aquifer Zone
Well No. 5	2,400	Confined
Avoset Foods	1,100	Unconfined
Land-O-Lakes	1,600	Composite

It is concluded from these data that the electroconductivity of the confined aquifer at the Land-O-Lakes well is in the 2,000 umhos/cm range, exceeding the upper level secondary standard as does Well No. 5. As each of these wells is located in the eastern portion of the City, this further demonstrates that the groundwater quality in the confined zone in the eastern portion of the City does not meet the Domestic Water Quality Standards.

The better quality water is contained in the unconfined zone generally in the depth range of 180 to 240 feet. However, as indicated in the groundwater study and as demonstrated by the other City wells (1, 4 and 6), nitrate concentrations, a primary water quality constituent, tend to be higher in the unconfined zone.

It was concluded in the groundwater study that pumping could approximately double; however, with Project Area buildout it is projected that groundwater pumping will nearly triple. It is concluded that the City should continue to rely on groundwater in the near future, but it will be necessary to begin planning conversion to alternate sources of supply. The design of the water distribution system should be able to accommodate two water supply conditions: utilizing deep wells for water supply in the near term, and a surface water supply source in the future. The surface water supply source will likely be taken into the distribution system near the southwest corner of the water distribution grid. This is also the vicinity where deep wells are planned to be located.

V. WATER SUPPLY AND DISTRIBUTION SYSTEM DESIGN CRITERIA AND CONSIDERATIONS

The deterioration of the water quality in Well No. 5 required additional evaluation of groundwater conditions in which it was concluded that provisions should be made to shift the source of supply from groundwater to surface water at some point in the future. The City is fortunate in that the source of surface water supply is on the same side of the community as the better quality groundwater. The water quality problem in Well No. 5 did not come to light until most of the water distribution system had been designed around wells placed in the southwest portion of the community. The plan to provide water to the community contains the following major elements:

1. Develop plan for replacement of Well No. 1 and Well No. 5.

2. Install new wells in locations as generally depicted for new water supply wells. New well installations would include the water supply well, a 0.85 million gallon surface mounted water storage tank and a water booster pump station fitted with two booster pumps with a combined capacity of approximately 3,000 gpm.

3. Develop wells as required to meet the demand of new development to the extent that groundwater meeting water quality standards can be located.

4. Institute a comprehensive groundwater monitoring program to monitor water levels and water quality to gain a better understanding of the sustainability of the groundwater to provide the City's water supply. The groundwater monitoring program would also provide information pertaining to the direction the groundwater is moving and how water quality in the various aquifer zones is changing. Based on the information developed in the groundwater monitoring program, better predictions can be made as to the ability of the groundwater to sustain as the City's water supply.

5. The City's distribution system has been designed to utilize groundwater, utilize a blend of groundwater and surface water or rely solely on surface water. If surface

water becomes the sole source of the City supply, a surface water treatment plant with the requisite amount of storage and pumping will need to be constructed. The water storage tanks and booster pump stations constructed at the well locations will be utilized to provide operational and fire storage in the same manner as they would do when the wells are the sole source of supply.

6. Depending on the dependability of the surface supply, it may be advantageous to implement an aquifer storage and recovery program by recharging the groundwater with treated surface water through the existing groundwater wells. This will render the groundwater in the vicinity of the wells usable, such that the wells can be utilized during severe drought periods when surface water supply may become very limited.

7. It is anticipated that the City will have several years to develop necessary information on groundwater availability to enable them to determine when the conversion to surface water will be needed.

8. Planning the conversion of water supply should begin. To effect the change in supply requires procurement of the surface supply, arrangements for delivery via the Delta-Mendota Canal or California Aqueduct, Department of Health Services (DHS) water permit modification, compliance with the National Environmental Policy Act and/or the California Environmental Quality Act, and project design and financing.

The following design criteria and considerations were utilized to determine the required improvements to provide water supply, storage, pumping and distribution to the undeveloped land within the Project Area.

Table V-1

WATER SUPPLY AND DISTRIBUTION SYSTEM DESIGN CRITERIA AND CONSIDERATIONS

WATER SUPPLY COMPONENTS	
WELLS	
ASSUMED AVERAGE FLOW RATE:	1,500 gpm
SPACING:	¼ to ½ mile
NUMBERS:	The number of wells required was estimated by subtracting the existing production capability from 1.20 times the maximum day water demand with 1 redundant well. Wells were considered to also provide all or a portion of the peaking capacity. Due to limitations of well field availability, potential cone of depression impacts related to the cumulative extractions from multiple wells, and the cost of well installation versus the cost of storage and booster pump station combinations, meeting peaking demand with storage and booster pumping is most appropriate. The 1.20 factor is the allowance for off time during the maximum day as wells cycle on and off during low demand periods to match supply with demand and unaccounted for well production.
SURFACE WATER SUPPLY	The limited availability of acceptable quality groundwater necessitates a plan which can accommodate an alternate supply. Based on the fact that even the best quality groundwater in the region is of marginal quality due to moderate to high concentrations of salinity and nitrates and the limited quantity available when excluding the lower aquifer as a source due to high salinity, the distribution system is sized to accept treated surface water equal to 100% of the maximum day demand of the community. The source of supply is assumed to be the California Aqueduct – San Luis Canal, the source preferred by DHS in the area.
WATER STORAGE COMPONENTS	
OPERATIONAL STORAGE:	Over any 24-hour period, water demands will vary. Typically, higher water demands will occur during the early morning when people are getting ready to go to work and school. Water demands will then decline to some nominal baseline level (depending on the proximity to and water use patterns of adjacent commercial/industrial areas), and will then begin to ramp up again depending on outside water needs (and corresponding temperature), again reaching a higher water demand in the early evening as people return home from work. The storage volume which is used to meet these high demand periods, above the nominal domestic production rate, is called operational storage. Typically, water treatment plants, wells and other supply sources are operated to match a baseline demand. This baseline demand is then augmented by flow from storage reservoirs or

additional wells during peak demand periods. The reservoirs and tanks are refilled when demands drop below the water production flow rate. For a typical system, the volume of water recommended to be held in reserve for operational storage should be at least equal to 25 percent of the total volume of water used on a maximum day. Fluctuations of flow throughout the day are not tracked by the City. These data can be used to provide a more accurate estimate of the operational storage requirement. Absent sound data to the contrary, the City should plan for an operational storage criteria of 25 percent of the maximum day demand unless otherwise provided by additional well capacity over 1.2 times the maximum day demand with the largest well out of service.

FIRE STORAGE:

Fire fighting storage requirements are identified in the Insurance Service Office, Inc. (ISO) guidelines and National Fire Code. These storage requirements are based on flow (in gpm), requirements for the building use type (i.e. commercial residential, school, industrial etc.), size of building (in square feet), and type of construction (wood frame, metal, masonry, installation of sprinklers, etc.). Once the fire flow requirement is established, it is multiplied by the required duration. This calculation provides an estimate of the total volume needed for fire flow reserve storage. The highest fire flow requirement in the City is 3,500 gpm for a duration of three hours for commercial/industrial areas. The resulting volume needed for fire flow reserve is 0.63 million gallons (mg). Fire flows of 2,000 gpm for a two-hour duration are required for residential areas, equating to a storage volume requirement of 0.24 mg. The need for fire storage can also be offset by additional well capacity similar to operational storage.

EMERGENCY STORAGE:

A reserve of potable water is also required to meet demands during emergency outage periods, when normal supply is interrupted. Such conditions may arise due to power failure, pumping equipment or transmission main failure, or the need for the City to take facilities out of service for inspection and repair. The required emergency storage volume is a function of several factors including the diversity of the sources of supply, redundancy, reliability of the production facilities, and the anticipated length of the emergency outage.

The treated water emergency storage requirement as published by the DHS in Title 22, Chapter 16 calls for a minimum emergency storage volume equivalent to 1.0 times the average day demand or about 50 percent of a maximum day demand. The American Waterworks Association (AWWA) guidelines call for minimum system storage equal to twice the average day demand in summer months plus fire flows.

As long as the City's primary source of supply is groundwater provided by numerous independently operated deep wells fitted with emergency power systems, the groundwater storage will continue to provide the emergency storage component. If in the future, treated surface water becomes the City's supply, an emergency water supply component of 4 MG should be added next to the water treatment plant.

<u>SURFACE OR ELEVATED STORAGE:</u>	The required storage can be provided in elevated tanks or through ground level tanks and booster pumps. There are pros and cons for both elevated and ground level storage; however, system operational flexibility, costs and aesthetics are the major considerations for the City's system. Elevated tanks will "float-on-the-system", so that the hydraulic gradeline outside the tank is virtually the same as the water level in the tank; therefore, the tank will drain only if the hydraulic grade line outside the tank drops below the water level in the tank. When water levels drop too low, it will be more difficult to provide customers not in the immediate vicinity of the tank with acceptable minimum pressures. The capital costs for the elevated storage tanks are considerably higher than for the at grade tank with booster pumps. There may be some minor energy cost savings associated with the elevated tank system; however, this savings would not outweigh the operational system flexibility and the aesthetic value of not seeing elevated tanks across the City skyline. Therefore, use of at grade tanks with associated booster pumps has been chosen as the preferred storage method.

DISTRIBUTION SYSTEM COMPONENTS

<u>BOOSTER PUMP STATIONS</u>

CAPACITY:	The total booster pump capacity must make up the difference between the well capacity and the peak instantaneous demand, which will be the controlling capacity criteria for the City at buildout of the Project Area. Currently, meeting the maximum day demand plus the fire flow requirement is the controlling capacity requirement. The capacity of each booster pump station will be provided by 2 pumps, the size to be determined at the facility design stage.
EMERGENCY POWER:	Emergency power shall be provided at the booster station to enable operation of the station at full capacity during power outages.

<u>PIPELINES</u>

MINIMUM DIAMETER:	8"
HAZEN WILLIAMS ROUGHNESS COEFFICIENT:	PVC – 140 D.I. – 120

SYSTEM PERFORMANCE		
MAXIMUM DAY DEMAND CONDITION	Pressure (min)[a]:	40 psi (Pounds per Square Inch)
	Pressure (max)[a]	75 psi
	Maximum Headloss, ft/1,000 ft:	5 ft/kft (Feet per 1,000 Feet)
	Maximum Velocity, ft/sec:	5-7 fps (Feet per Second)
PEAK HOUR DEMAND CONDITION	Pressure psi (min)[a]:	40 psi
	Pressure psi (max)[a]	75 psi
	Maximum Headloss, ft/1,000 ft:	7 ft/kft
	Maximum Velocity, ft/sec:	6-8 fps
FIRE FLOW DEMAND CONDITION	Pressure (min)[b]:	20 psi
	Headloss (min/max):	10 ft/kft
	Velocity (min/max):	12 fps

a Pressure assumed at the pad elevation.
b Pressure assumed to be at the hydrant location.

VI. WATER SUPPLY COMPONENTS

For economic reasons, it is appropriate to continue the development of the City's water supply around implementation of deep wells as long as groundwater meeting the Domestic Water Quality Standards is available. It is expected that at some time in the future transition to a surface water supply source will be necessary. Based on both economic and groundwater considerations, reliance on the well production rate is minimized by providing all peak water requirements by pumping out of storage.

Table VI-1 summarizes the water demand components based on a water supply system utilizing groundwater wells as the source of supply to meet the maximum daily flow demand and utilizing water stored in surface mounted water storage tanks coupled with booster pump stations to meet fire flow and peak flow requirements.

Table VI-1

PROJECT AREA
WATER DEMAND SUMMARY

Projected Water Demand (gpm)		Maximum Day		Peak Hour
Current Demand		2,000 [1/]		
Undeveloped Area		3,238		
Total		**5,238**		**10,476**
Required Production Capacity		6,286		
Current Well Capacity		2,700 [2/]		2,700
Needed Supply Capacity		**3,586**		**7,776**
Number Of Wells At 1500 Gpm		3		
Storage Required (Gallons)	Operation	Fire Flow	Emergency	Total
	1,886,000	630,000	0	2,516,000 [3/]

[1/] Includes allowance for infill
[2/] Assumes largest well out of service
[3/] One 850,000 gallon tank at each of the 3 well sites

VII. RECOMMENDED WATER SYSTEM INFRASTRUCTURE TO SERVE PROJECT AREA BUILDOUT

Figure 2 presents the general locations and sizes of the recommended water system components to serve the Project Area. The combination of water supply wells, storage tanks, booster pump stations and pipeline distribution was arrived upon through numerous computer model simulations evaluating the following conditions:

A. WELL WATER SUPPLY CONDITION

1. Peak hour flow condition with Project Area buildout.

2. Maximum day demand plus 3,500 gpm fire flow at two locations.

3. Maximum day demand plus 2,000 gpm fire flow at two locations.

B. SURFACE WATER SUPPLY CONDITION

1. Peak hour flow condition with Project Area buildout.

2. Controlling maximum day plus 3,500 gpm fire flow at northeastern corner of Project Area, opposite the point of connection of surface supply and proposed well locations.

The first water supply condition evaluated was the addition of three water supply wells with appurtenant storage and pumping facilities southerly and westerly of the City to determine main water transmission pipeline sizing to service the Project Area. Once the infrastructure was configured to deliver water under this condition, the surface water condition was tested and the water distribution facilities adjusted based on system performance.

The distribution system looping was generally developed on approximately one-quarter mile grid spacing to establish a pipeline network connected at appropriate locations to the existing system which can be easily infilled with distribution sub-mains as the area develops.

Under this type of major distribution looping pattern, the City does not have to rely on timely installation of distribution pipelines within each development to convey water across the City, allowing development an opportunity to be less constrained with respect to concentric growth.

The water distribution system must operate under a multitude of different operating scenarios which vary depending on which wells may be off due to maintenance, where and how long fire flow demands occur within the City and if and when the source of supply changes from groundwater to surface water. The analysis has demonstrated that the system can operate under the numerous water supply and demand scenarios which were selected to represent the extreme operating conditions.

The results as measured by the maximum pipe velocities and maximum pressure drops under the peak hour demand condition and the controlling maximum day plus fire flow condition are presented in Table VII-1. With well pressures in the 65 psi to 70 psi range as reported by the Public Works Department, the system meets the specified performance criteria.

Table VII-1

SYSTEM PERFORMANCE SUMMARY

	Well Supply	Surface Supply
Peak Hour Flow		
Max Pressure Drop (psi)	10.6	20.3
Max Pipe Velocity (fps)	5.6	7.5
Controlling Max Day Plus Fire Flow		
Max Pressure Drop (psi)	25.1	31.4
Max Pipe Velocity (fps)	8.4	8.3

It must be kept in mind that this Water Master Plan is a guide for development of the water supply and distribution infrastructure. The location of facilities are somewhat general, and the final location of facilities will certainly vary from the plan to accommodate specific site considerations and construction phasing.

VIII. PROJECT COST ESTIMATE

An itemized list of the water system improvements necessary to serve the Project Area buildout with continued utilization of well water is provided in Table VIII-1. Planning level unit costs were developed and applied to estimated quantities to compute the estimated construction costs. A 25% contingency factor is added to cover unforeseen construction costs and 15% is added to cover engineering, legal and administrative costs. Costs for miscellaneous plan implementation efforts, such as the groundwater monitoring plan, are assumed to also be covered by the contingency. The project cost estimate is broken down by major project component and factors applied on a component-by-component basis. The total estimated cost of the water improvements to accommodate Project Area buildout is $9,155,438. The unit cost based on the daily demand of the area to be serviced is $4.25 per gallon per day provided.

The estimated cost to convert to a surface water supply is itemized in Table VIII-2. Conversion of the supply from groundwater to surface water will be an expensive transition. Typically, grants and low interest loans are available to assist small communities in addressing drinking water quality problems. A portion of the cost will be paid for by existing users and a portion of the cost will be paid for by new connections. It is recommended that the City begin the planning for water supply conversion, an aspect of which will be the financial plan.

Table VIII-1

ESTIMATED CAPITAL COST OF RECOMMENDED MAJOR WATER INFRASTRUCTURE TO MEET PROJECT AREA BUILDOUT (GROUNDWATER SUPPLY)

Component	PROJECT COST ESTIMATE				COMPONENT COST BREAKDOWN				
	Unit	Quantity	Unit Cost ($)	Cost ($)	Subtotals ($)	Contingency ($)	Subtotals ($)	E, L & A ($)	Comp. Cost ($)
Municipal Supply Wells									
1500 gpm production well	each	3	75,000	225,000	225,000	56,250	281,250	42,188	323,438
Storage Reservoirs									
Well Site Reservoir: 0.85 mg	each	3	340,000	1,020,000	1,020,000	255,000	1,275,000	191,250	1,466,250
Booster Pump Stations									
Well Station 3500 gpm	each	3	620,000	1,860,000	1,860,000	465,000	2,325,000	348,750	2,673,750
Pipelines									
8" Water with Valves and Appurtenances	lf	1,200	45	54,000					
10" Water with Valves and Appurtenances	lf	29,900	50	1,495,000					
12" Water with Valves and Appurtenances	lf	9,200	55	506,000					
Right-of-Way	lf	40,300	30	1,209,000	3,264,000	816,000	4,080,000	612,000	4,692,000
Subtotal				6,369,000	6,369,000				
25% Contingency				1,592,250		1,592,250			
Subtotal				7,961,250			7,961,250		
15% Engineering, Legal, Administration				1,194,188				1,194,188	
Total Estimated Construction Cost for the Project Area Buildout				9,155,438					9,155,438

Table VIII-2

ESTIMATED COST OF CONVERSION TO SURFACE WATER SUPPLY

DESCRIPTION	*QUANTITY*	*UNITS*	*INSTALLED UNIT COST*	*TOTAL INSTALLED COST*	*25% CONT.*	*COST TOTAL*
PURCHASE WATER SUPPLY	7000	AC FT	$ 1,200	$ 8,400,000	$ 2,100,000	$10,500,000
20" MAIN TRANSMISSION PIPELINE	25000	L.F.	$ 100	$ 2,500,000	$ 625,000	$ 3,125,000
WATER TREATMENT PLANT	8.0	MGD	$ 1,200,000	$ 9,600,000	$ 2,400,000	$12,000,000
4 MG WATER STORAGE TANK	1	EACH	$ 2,000,000	$ 2,000,000	$ 500,000	$ 2,500,000
12" PIPELINE	2,600	L.F.	$ 55	$ 143,000	$ 35,750	$ 178,750
			SUBTOTALS	22,643,000	5,660,750	28,303,750
			ENGIN., LEGAL & ADMIN @ 15%			4,245,563
			SURFACE WATER SUPPLY CONVERSION COST			32,549,313

IX. PROJECT IMPLEMENTATION

The timing of facility needs is very sensitive to the rate of growth and the sequence of development. It is premature to formulate a definitive development schedule at this time.

At present, with all City wells including Well No. 5 in operation, the recommended maximum fire flow rate of 3,500 gpm cannot be met. This is normally the case in smaller cities. Currently, the maximum day demand including allowance for infill within the developed area is 2,000 gpm. Current total pumping capacity is 4,400 gpm. Fire flow capability at the maximum day demand is therefore 2,400 gpm. The goal will be met as the City grows.

Attention should first be directed to developing the plan for replacement of Well No. 1 and Well No. 5 to secure the supply for the existing users.

City of Gustine. *City of Gustine General Plan*. Gustine, California, February, 2002.

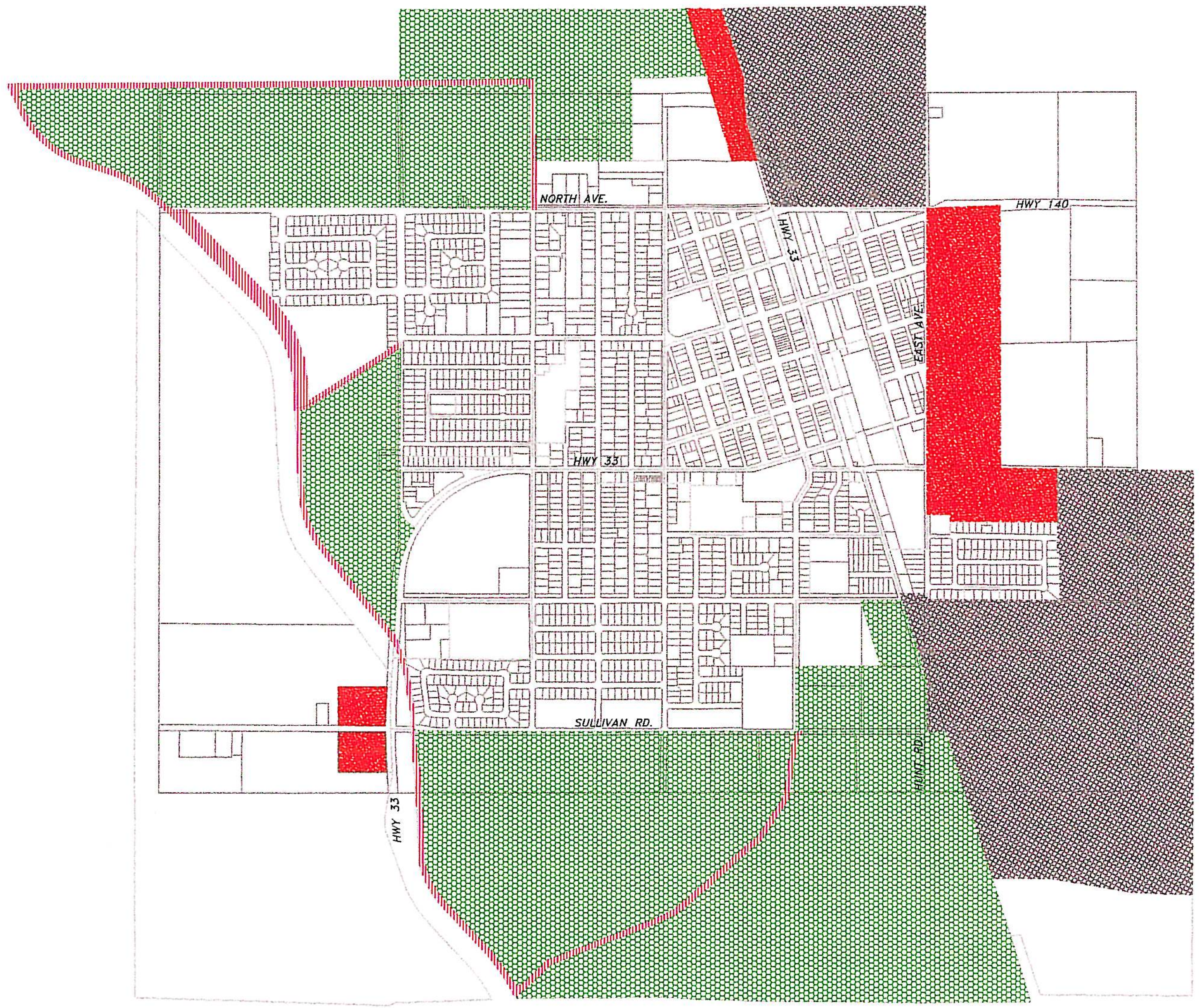
Kenneth D. Schmidt and Associates. *Groundwater Conditions in the Vicinity of the City of Gustine, California, Draft Report*. Fresno, California, September 2001.

FIGURES

FIGURE 1

CITY OF GUSTINE
YEAR 2020

PROJECT AREA LAND USE GENERAL PLAN BUILDOUT



N

1200 600 0 1200

SCALE IN FEET

LEGEND

- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- PARKS

STODDARD & ASSOCIATES
CONSULTING CIVIL ENGINEERS AND LAND SURVEYORS

JULY, 2002

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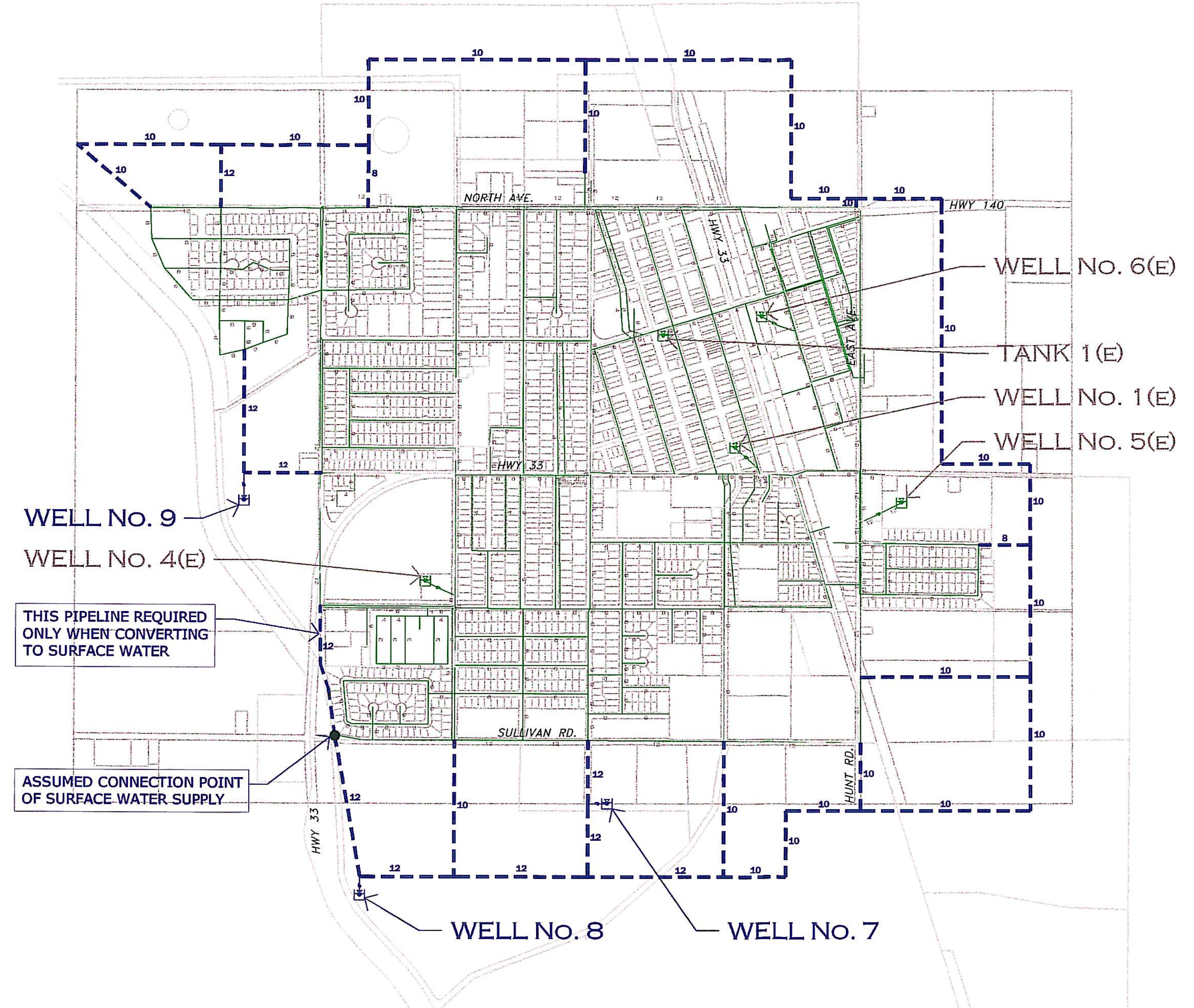

JULY, 2002

FIGURE 2

CITY OF GUSTINE
YEAR 2020

PROJECT AREA FACILITIES MAP

N

1000 0 1000
SCALE IN FEET

LEGEND

WELL No. 1(E)	**= EXISTING WELL (TYP)**
TANK No. 1(E)	**= EXISTING TANK**
———	**= EXISTING PIPE (SIZE AS NOTED)**
WELL No. 7	**= PROPOSED WELL (TYP)**
- - - - -	**= PROPOSED BACKBONE DISTRIBUTION MAINS (SIZE AS NOTED)**

STODDARD & ASSOCIATES
CONSULTING CIVIL ENGINEERS
AND LAND SURVEYORS

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