Project Justification

City of Live Oak Water Supply Reliability Well

Table 4 – 2014 IRWM Drought Solicitation Project Summary Table		
Drought Project Element		Project Name/ID Add 1 column per Project
D.1	Provide immediate regional drought preparedness	1
D.2	Increase local water supply reliability and the delivery of safe drinking water	1
D.3	Assist water suppliers and regions to implement conservation programs and measures that are not locally cost-effective	
D.4	Reduce water quality conflicts or ecosystem conflicts created by the drought	
IRWM Project Element		
IR.1	Water supply reliability, water conservation, and water use efficiency	1
IR.2	Stormwater capture, storage, clean-up, treatment, and management	
IR.3	Removal of invasive non-native species, the creation and enhancement of wetlands, and the acquisition, protection, and restoration of open space and watershed lands	
IR.4	Non-point source pollution reduction, management, and monitoring	
IR.5	Groundwater recharge and management projects	
IR.6	Contaminant and salt removal through reclamation, desalting, and other treatment technologies and conveyance of reclaimed water for distribution to users	1
IR.7	Water banking, exchange, reclamation, and improvement of water quality	1
IR.8	Planning and implementation of multipurpose flood management programs	
IR.9	Watershed protection and management	
IR.10	Drinking water treatment and distribution	1
IR.11	Ecosystem and fisheries restoration and protection	

Project Description

Design and construct new treated drinking water supply and storage on the east side of the City to alleviate the existing water supply deficit.

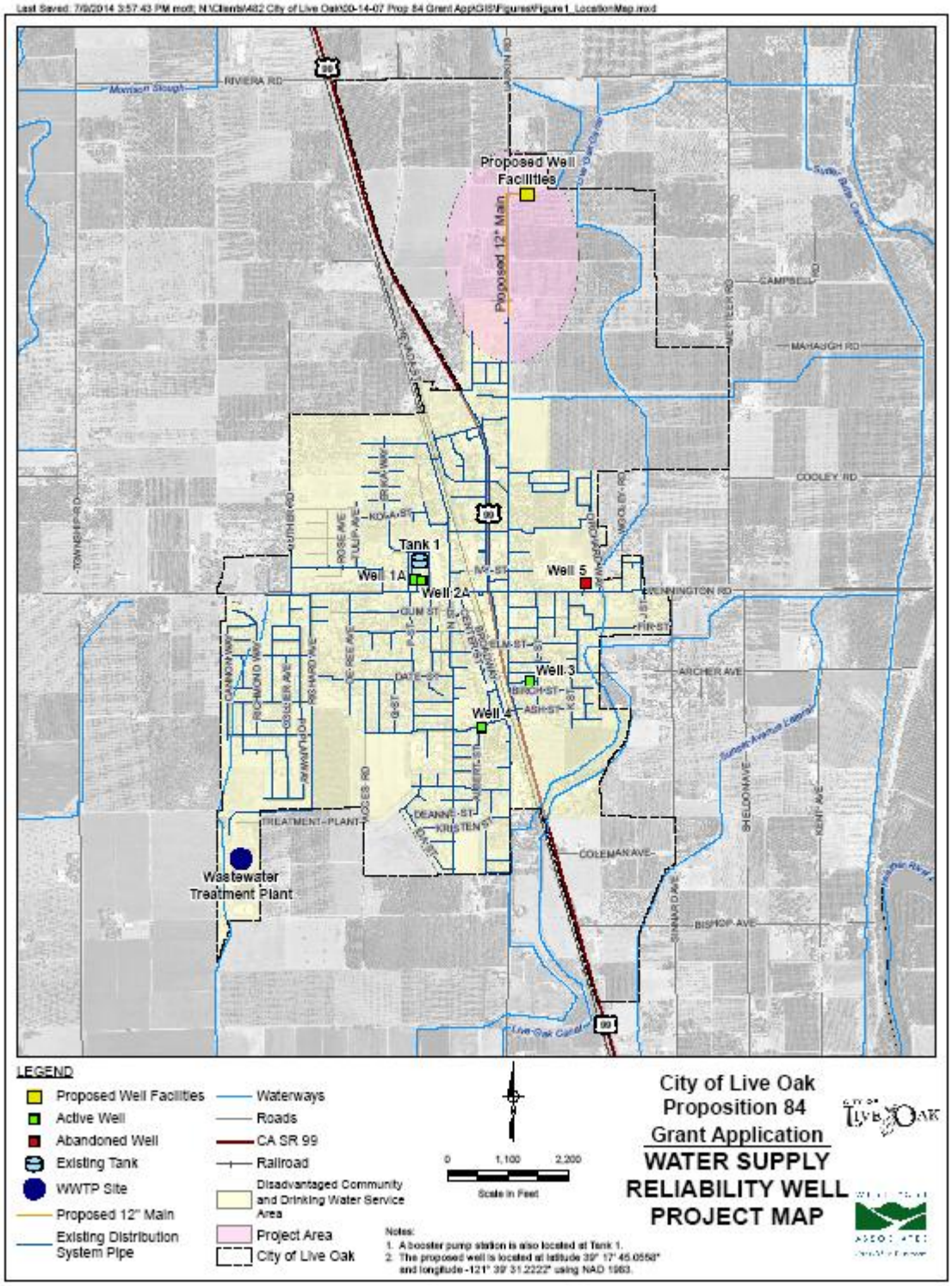
Additional Project Description Project Information:

How Will Project Help Alleviate Drought Impacts: As described in Attachment 2, new water supply is urgently needed on the east side of town to remedy the current supply deficiency and for safety (to provide fire flow). The City's 2009 Water Master Plan shows a 1,220 gpm deficiency on maximum day demand, and a 1,435 gpm deficiency in maximum day demand plus fire flows (page 3-10). This situation is in immediate need of remedy because with the current drought, water levels in other City wells are dropping and this is causing a further reduction in supply availability. At the present time, the City has only one operational well on the east side of town. If this one operational well were to fail, the City would have no water supply east of Highway 99. Since water currently produced west of Highway 99 is not adequately distributed to the east side of the City due to insufficient distribution system crossings under the Union Pacific Railroad right-of-way, this loss of supply would result in inadequate fire protection. The goal of the project is to produce an additional 2,000 gallons per minute of water supply on the east side of the City, provide wellhead treatment for that production, and provide ground level storage to both meet the State supply requirements and provide adequate fire protection. This new, and urgently needed, supply will provide drought mitigation, and fill the deficiency in maximum day and fire flows described above. The project will also provide redundancy in supply in the area of the City east of Highway 99.

Does Project Fit one or more of eligible drought projects? Yes, this project meets one of the four eligible drought project types identified in Section C of the PSP. The new supply, treatment, and storage will increase the local water supply reliability and deliver a safe drinking water supply that meets all water quality requirements for a municipal water supply in California.

Why is Expedited Funding Needed? Funding is needed because the City of Live Oak is a disadvantaged community and, alone, is unable to fund the planning, design and construction of this project. Grant assistance through the IRWM drought program is immediately needed so that the City is able to implement this project and thereby meet maximum day demands and fire flows.

Project Map:


Proposed Well Facilities
Proposed 12" Main
Tank 1
Well 1A
Well 2A
Well 3
Well 4
Well 5
Wastewater Treatment Plant
RIVIERA RD
CAMPBELL RD
MAHAUGH RD
COOLEY RD
BENNINGTON RD
ARCHER AVE
COLEMAN AVE
BISHOP AVE
TREATMENT PLANT
LEGEND
Proposed Well Facilities
Active Well
Abandoned Well
Existing Tank
WWTP Site
Proposed 12" Main
Existing Distribution System Pipe
Waterways
Roads
CA SR 99
Railroad
Disadvantaged Community and Drinking Water Service Area
Project Area
City of Live Oak
0 1,100 2,200
Scale in Feet
Notes:
1. A booster pump station is also located at Tank 1.
2. The proposed well is located at latitude 39° 17' 45.0558" and longitude -121° 39' 31.2222" using NAD 1983.
City of Live Oak
Proposition 84
Grant Application
WATER SUPPLY
RELIABILITY WELL
PROJECT MAP

Project Physical Benefits

The City of Live Oak understands that grant eligible projects for funding through the 2014 IRWM Drought Grant Solicitation must be consistent with an adopted IRWM plan, and must provide one of the following primary benefits:

1. Projects and programs that provide immediate regional drought preparedness
2. Increase local water supply reliability and the delivery of safe drinking water
3. Assist water suppliers and regions to implement conservation programs and measures that are not locally cost-effective
4. Reduce water quality conflicts or ecosystem conflicts created by the drought

As described in the project description, <u>the project provides an increase in local water supply reliability and the delivery of safe drinking water</u>.

The City of Live Oak also recognizes that the project must yield multiple benefits; including one or more of the elements (PRC§75026.(a)) as other benefit(s):

1. <u>Water supply reliability, water conservation, and water use efficiency</u>
2. Stormwater capture, storage, clean-up, treatment, and management
3. Removal of invasive non-native species, the creation and enhancement of wetlands, and the acquisition,
4. protection, and restoration of open space and watershed lands

5. Non-point source pollution reduction, management, and monitoring
6. Groundwater recharge and management projects
7. Contaminant and salt removal through reclamation, desalting, and other treatment technologies and
8. conveyance of reclaimed water for distribution to users
9. Water banking, exchange, reclamation, and improvement of water quality
10. Planning and implementation of multipurpose flood management programs
11. Watershed protection and management
12. <u>Drinking water treatment and distribution</u>
13. Ecosystem and fisheries restoration and protection

The project is eligible because it has the following physically quantifiable benefits:

1. Water supply reliability through new water supply production (primary benefit) – see Table 5.1
2. Drinking water treatment to remove arsenic (secondary benefit) – see Table 5.2
3. Lower nitrate concentration at new well facilities due to well depth and/or screening of selected intervals with the highest quality water (secondary benefit) – see Table 5.3

Table 5.1 – Annual Project Physical Benefits

Project Name: _Water Supply Reliability Well_____

Type of Benefit Claimed: _____New Water Supply Production_____

Units of the Benefit Claimed : _Acre-feet per year (AF/Y)_ _____

Additional Information About this Benefit__Water produced will provide supply reliability, meet max day and fire demands

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (c) – (b)
2016	0	800	800
2017	0	3,200	3,200
2018	0	3,200	3,200
2019	0	3,200	3,200
2020	0	3,200	3,200
…	…	…	…
2066 (Last Year of Project Life)	0	2,400	3,200
Totals over Project Life (50 years)	0	160,000	160,000

Comments: Calculated by assuming 2,000 gallons per minute produced from new well. Well life is assumed to be 50 years. Benefit start date is October 2016 and end date is September 2066.

Table 5.2 – Annual Project Physical Benefits

Project Name: _Water Supply Reliability Well_____

Type of Benefit Claimed: _____Drinking Water Treatment (Arsenic)_____

Units of the Benefit Claimed_:_micrograms per liter (ug/l)_____

Additional Information About this Benefit__Arsenic Treatment will Reduce levels below MCL of 10 ug/l

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (c) – (b)
2016	20.6	2	18.6
2017	20.6	2	18.6
2018	20.6	2	18.6
2019	20.6	2	18.6
2020	20.6	2	18.6
...	...	...	...
Last Year of Project Life (2066)	20.6	2	18.6

Comments: The "Without Project" condition is based on the Well #5 average arsenic concentration of 20.6 ug/L due to the fact that the Water Supply Reliability Well Project will be both replacing Well #5 and increasing supply capacity from what Well #5 previously produced. Using commercially available arsenic treatment, it is anticiapted that treated water quality will fully remove arsenic from the drinking water supply. Therefore, the "With Project" condition conservativly estimates that the concentration will be reduced to 2 ug/l, or 1 log removal. The project life is estimated to be 50 years. Benefit start date is October 2016 and end date is September 2066.

Table 5.3 – Annual Project Physical Benefits			
Project Name: _Water Supply Reliability Well_____			
Type of Benefit Claimed: _____Lowered Nitrate Concentration at New Well Facilities			
Units of the Benefit Claimed : _milligrams per liter (mg/l)_____			
Additional Information About this Benefit__Nitrate concentrations will be reduced compared to Well #5 due to a different well location, a greater well depth at the new well facilities, and screening of selected intervals with the highest quality water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (c) – (b)
2016	27.7	4.97	22.7
2017	27.7	4.97	22.7
2018	27.7	4.97	22.7
2019	27.7	4.97	22.7
2020	27.7	4.97	22.7
...	...	...	...
Last Year of Project Life (2066)	27.7	4.97	22.7
Comments: The "Without Project" condition is based on the Well #5 average nitrate concentration of 27.7 mg/L. The "With Project" condition, is conservatively based on the 4.97 mg/L nitrate concentration documented in the City's 2013 Consumer Confidence Report for the existing operational wells (Wells 1A, 2A, 3, and 4) because it is anticipated that the nitrate concentration for new wells will be similar to, or less than, that found in the existing operational wells. The project life is estimated to be 50 years. Benefit start date is October 2016 and end date is September 2066.			

Attachment 3: Project Justification

Technical Analysis of Physical Benefits Claimed

Analysis of Water Supply Reliability Benefit (Primary Benefit):

As presented in the project description above, without the use of Well #5, the City of Live Oak is left with a supply deficiency on the east side of town. As shown in the table below, Well #5 was the City's most productive well but was abandoned due to poor water quality. Without Well #5 operational, the other wells in the system are not able to produce enough supply on peak demand days and times. A diminished supply results in diminished flows and pressures that are noticeable to the residents of the community. Not only are those levels of service noticeable to the residents during normal use, but the Sutter County Fire Department has voiced repeated concerns for the safety of residents in a fire emergency due to the lack of adequate fire flows. Figure 1 shows those areas of the City that are deficient in fire flow if Well #3 was not operational during a fire emergency. This figure illustrates how dire the situation is east of State Route 99.

City of Live Oak Well Summary Table

Well ID	Date Installed	Casing Diameter (in)	Total Depth (ft)	Top of Screen (ft)	Bottom of Screen (ft)	Production Rate (gpm)	Drawdown in Well (ft)	Specific Capacity (gpm/ft)	Status
1A	1951	10	292	292	NA	600	40.5	15	Active
2A	1951	10	393	393	NA	650	46	14	Active
3	1960	13	426	100	NA	750	41	18	Active
4	1983	16	426	390	NA	935	42	22	Active
5	1983	16/14	410	207	NA	1350	NA	NA	Abandoned

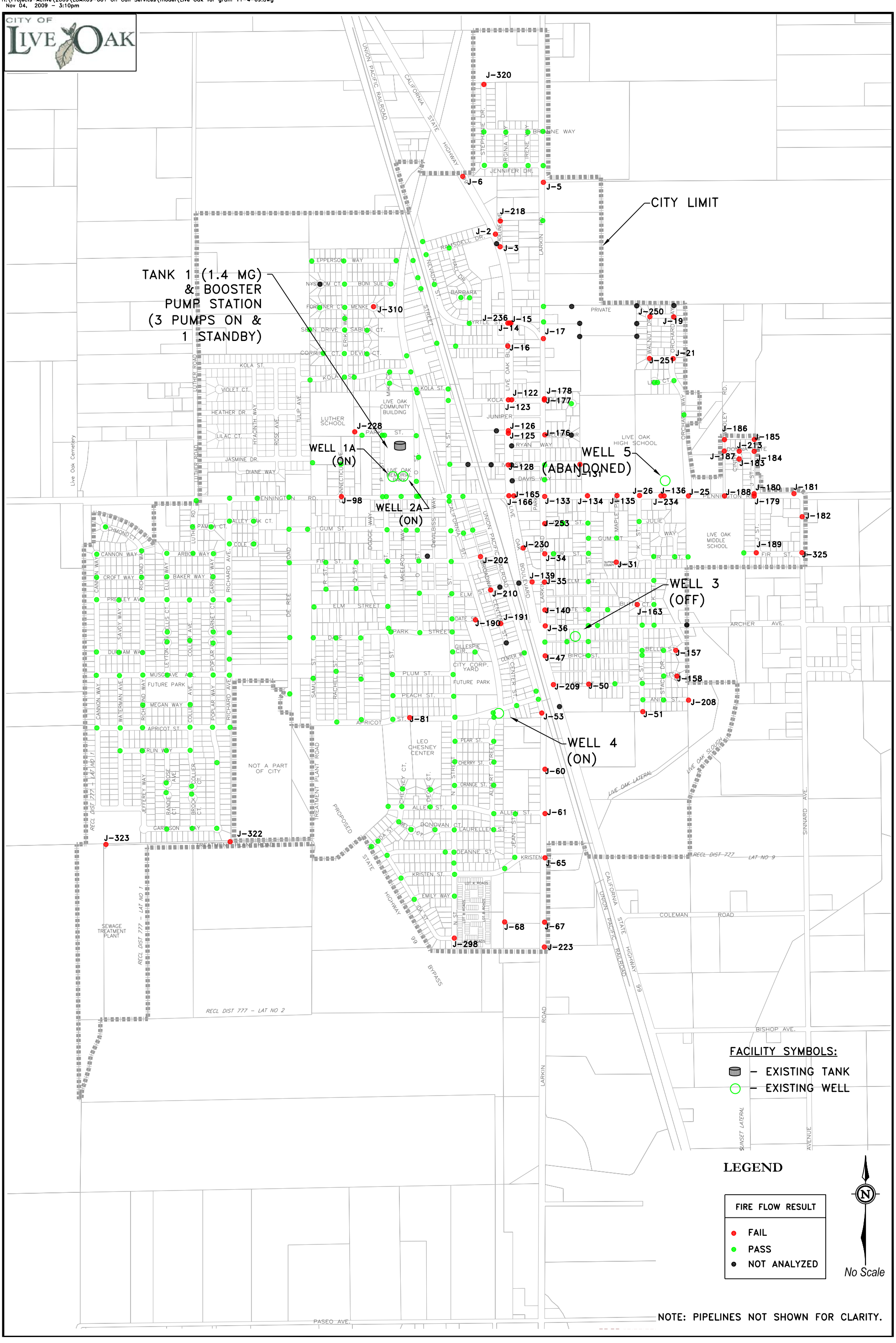
As noted earlier, in late 2009 the City completed its Water Master Plan, which identified inadequate supply to meet its maximum day demand, and its maximum day demand (MDD) plus fire flows. Per California Waterworks standards (Title 22, Chapter 15, Section 64554, R-14-03), the system shall be capable of meeting maximum day demand with the highest-capacity source off line. The existing reliable supply of Wells 1A, 2A, and 3 is not sufficient to meet MDD. Therefore, at least one new well needs to be added. The plan shows a 1,220 gpm deficit on maximum day demand, and a 1,435 gpm deficit in maximum day demand plus fire flows. These deficits are directly attributable to the loss of Well #5 and the reduced productivity of the remaining wells now that wellhead arsenic treatment has been added to meet the State's revised arsenic MCL of 10 µg/L (reduced from the previous 50 µg/L). These deficits are correctable with the addition of approximately 2,000 gpm of new reliable production. Available records for Live Oak's existing wells did not include the Well Drillers Reports, but based on communications with City staff, it is believed that these wells were constructed using the cable tool method and were constructed as open bottom wells or a combination of open bottom and mills slot screen. All new wells in the City will be completed using the reverse rotary drilling method and constructed using stainless steel wire-wrap screen. The increase in open area will provide for increased flow rates as compared to the existing wells.

Reliability of Additional Supply from Underlying Groundwater Aquifer

No water level data is available for the City of Live Oak municipal wells. However, hydrographs for nine wells in the area surrounding Live Oak were obtained that have water level data extending back as far as 1947 and up to 2005. The monitoring well groundwater elevations indicate a groundwater flow direction to the south, at a gradient of about 2.4 feet per mile. Similar to Bulletin 118, these data show that

Figure 1
Source: Draft 2009 Water Master Plan

H:\Projects-Active\2009\LOAK09-001 On Call Services\model\Live Oak for grant 11-4-09.dwg
Nov 04, 2009 - 3:10pm



ECO:LOGIC ENGINEERING - **DRAFT**
CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 4-1
EXISTING WATER SYSTEM FIRE FLOW ANALYSIS

groundwater fluctuations are typically no more than 10 feet. Six of the wells do not show any long-term decline in groundwater elevations. In the other wells, long-term declines appear to be less than five feet. In the drought period of 1987 to 1992, additional declines in individual years of two to four feet are visible only in some wells, but water level recoveries in winter months were generally not as pronounced as in wetter years. Hydrographs for the three closest wells to the Live Oak municipal wells, 16N03E07D002M, 17N03E30N001M and 17N03E33P001M, show no long term water level declines, but, as shown in Figure 2 (Figure 3-2 from the City's 2009 Draft Urban Water Management Plan, page 3-7), do show decreased recharge during the drought periods. However, these decreases are generally on the order of six feet or less. Trend lines for two of the three wells actually indicate rising water levels over the 60-year period. Based on these data, there are no reliability issues with the subbasin at current pumping rates or increased production from the proposed project (City of Live Oak: Urban Water Management Plan – Draft, October 2009, page 3-6).

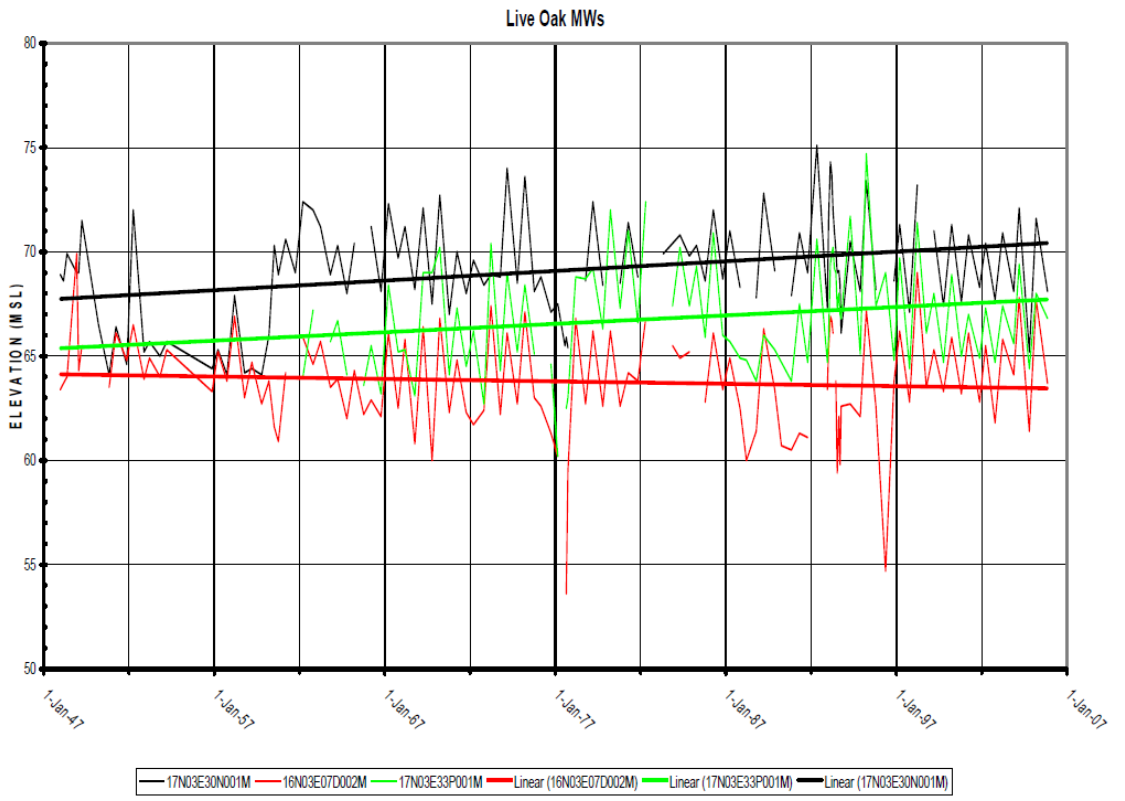


Figure 3-2
Groundwater Levels of Area Monitoring Wells Showing Long-term Trends

Figure 2. Groundwater Levels of Area Monitoring Wells Showing Long-term Trends
Source: 2009 Draft Urban Water Management Plan, City of Live Oak (page 3-7)

Analysis of Drinking Water Treatment Benefit (Secondary Benefit):

The City of Live Oak's Well #5 has been repeatedly tested and shown elevated arsenic and nitrate levels. The well is very old, and because of its age it is not able to be economically repaired and upgraded in order to facilitate arsenic and nitrate treatment and removal systems. In 2009, the City was awarded funding to install an arsenic and nitrate removal system at Well #5, but due to the age and level of repair

needed to the well itself, the costs necessary to fully complete the project were not feasible and the City was forced to abandon the upgrade and remove the well from service. New well facilities would effectively replace Well #5, and produce comparatively lower arsenic and nitrate concentrations.

Water quality of new wells is anticipated to be similar to the existing operational wells and would require the same arsenic treatment as the existing wells. During well design the City will attempt to maximize water quality to avoid the need for nitrate treatment. Part of this design strategy could include deeper wells and/or screening selected intervals with the highest quality water.

Arsenic treatment on new wells is likely unavoidable, however Live Oak will characterize the vertical profile of arsenic concentrations during exploratory drilling and monitoring well construction. This exploratory data will be used to select screened intervals for wells that avoid areas of highest arsenic concentration. Sutter County's 2012 Groundwater Management Plan describes arsenic occurrence as follows:

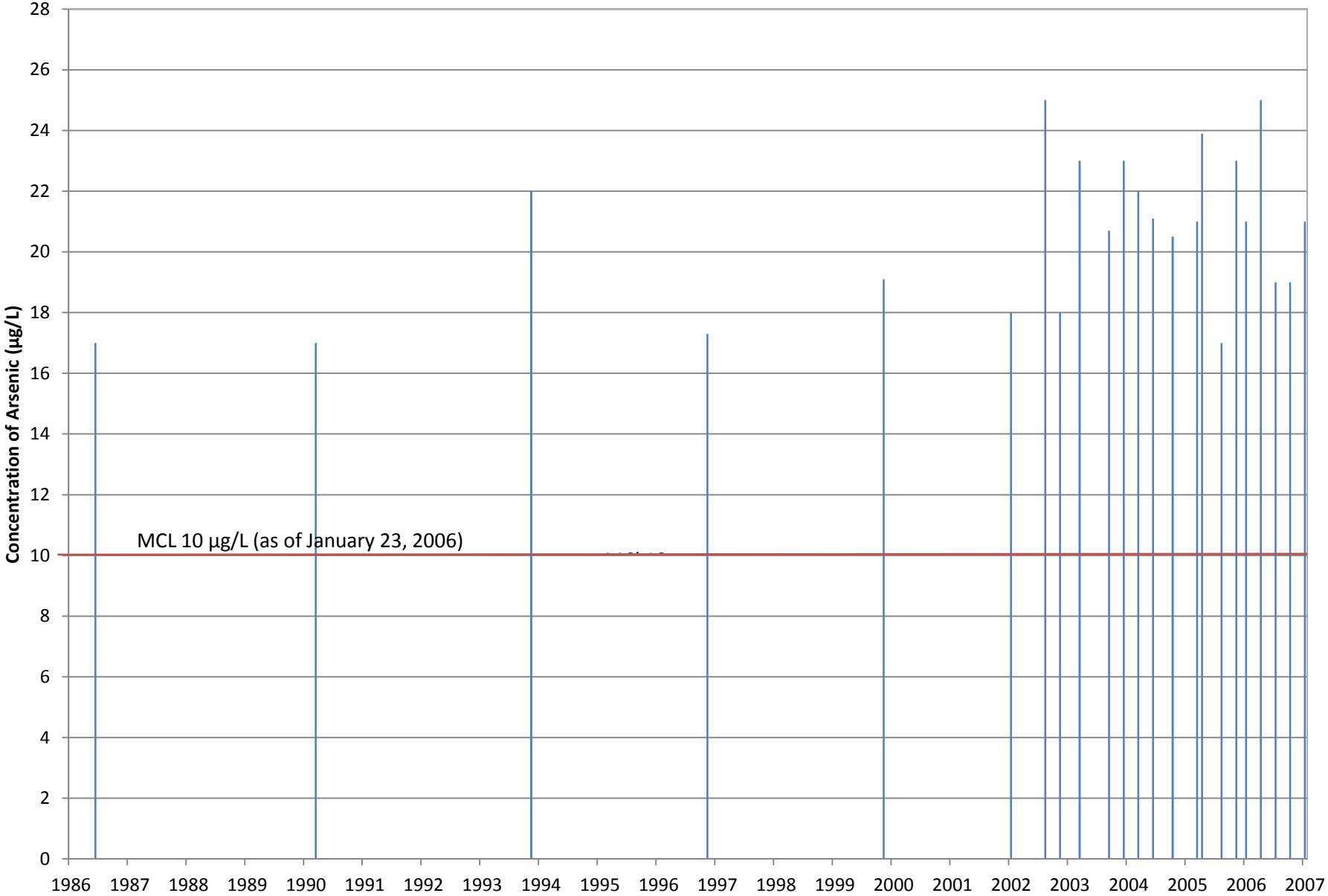
> "Arsenic is a naturally occurring element commonly found in alluvial sediments. Its presence in groundwater is a result of the dissolution of the element in sediments containing minerals containing arsenic. The CDPH has established a primary MCL of 10 µg/L for arsenic. Arsenic concentrations are near to or above the CDPH MCL throughout Sutter County in each of the aquifer zones assessed; conversely, concentrations of arsenic below the CDPH MCL are also present throughout the County in each of the aquifer zones assessed. Countywide, arsenic concentrations do not appear to be isolated to any one specific aquifer zone in the subsurface. However, recent data analysis suggests a possible correlation between elevated arsenic concentrations and the presence of volcaniclastic material of the Sutter Buttes Rampart formation. Concentrations of arsenic in the stratigraphic units that occur above and below the Rampart are generally less than 10 µg/L, whereas concentrations of arsenic within the Rampart material are between 10 to 370 µg/L (Steven T. Springhorn, "Stratigraphic Analysis and Hydrogeologic Characterization of Cenozoic Strata in the Sacramento Valley near the Sutter Buttes," M.Sc. Thesis, California State University, Sacramento, 2008). Concentrations of arsenic tend to be under the CDPH MCL southeast of Highway 99 and in the shallow aquifers" (page 32).

Arsenic concentration measured at Well #5 is summarized on Figure 3 and shows that arsenic levels at that well location have always exceeded the 10 µg/L MCL. Utilizing the same treatment process being used for the other City wells, arsenic will be reduced to less than the MCL and may be removed completely. A final concentration of 2 µg/L (one log removal based on the average well #5 arsenic concentration) is assumed to be a conservative estimate of mass removed. Schematic drawings of the City's existing arsenic treatment process at Well #4, which is similar to the treatment process at the other City wells, is provided as Attachment A.

Analysis of Lowered Nitrate Concentration Due to Well Depth and/or Screening of Selected Intervals (Secondary Benefit):

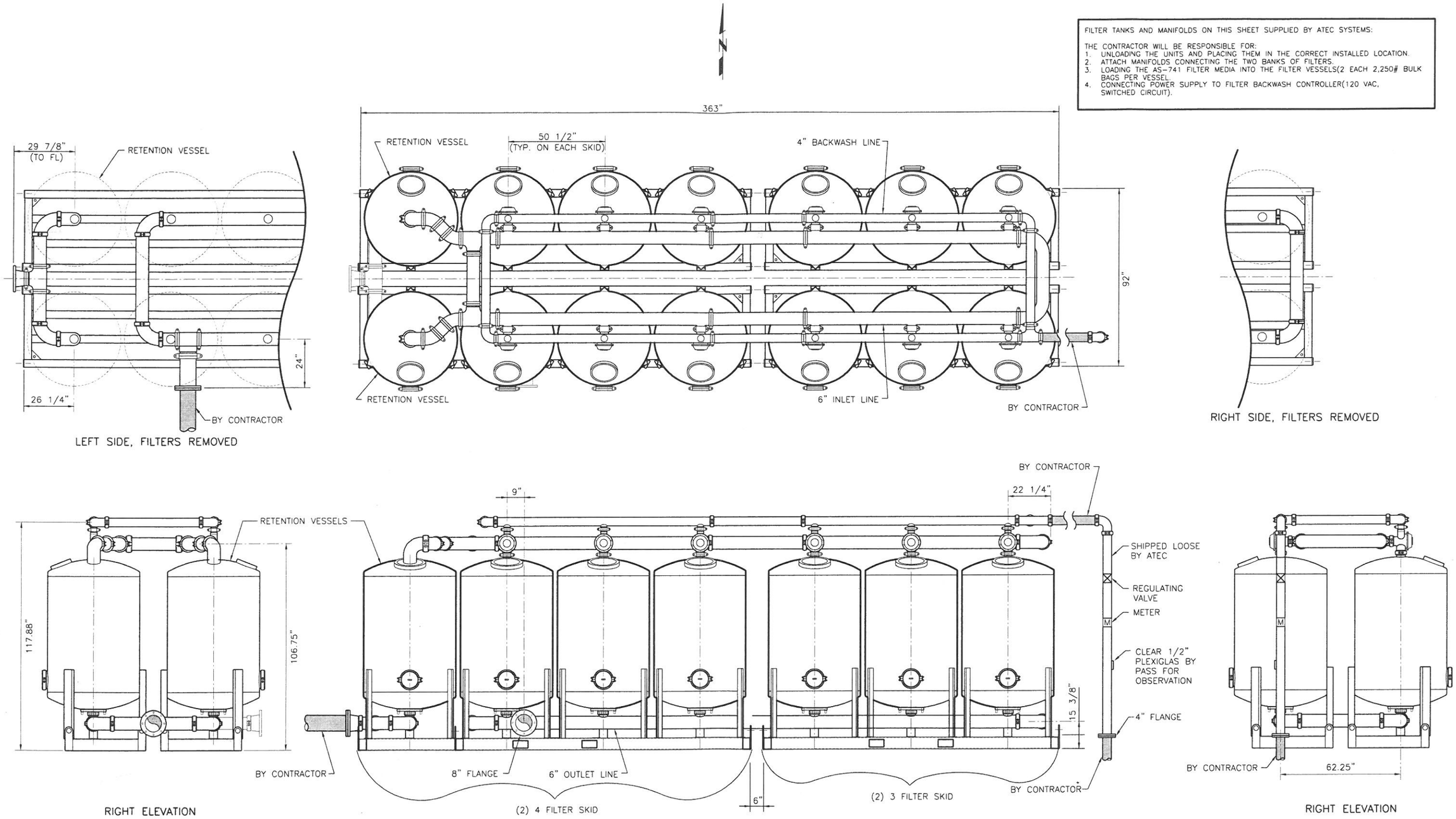
As mentioned above, during well design the City will attempt to maximize water quality to avoid the need for nitrate treatment. Part of this design strategy could include deeper wells and/or screening selected intervals with the highest quality water. As with arsenic concentrations, the City will characterize the vertical profile of nitrate concentrations during exploratory drilling and monitoring well construction. This exploratory data will be used to select screened intervals for wells that avoid areas of highest nitrate concentration. Sutter County's Groundwater Management Plan describes nitrate occurrence as follows:

Figure 3: Historical Arsenic Concentrations for Well #5



FILTER TANKS AND MANIFOLDS ON THIS SHEET SUPPLIED BY ATEC SYSTEMS:

THE CONTRACTOR WILL BE RESPONSIBLE FOR:
1. UNLOADING THE UNITS AND PLACING THEM IN THE CORRECT INSTALLED LOCATION.
2. ATTACH MANIFOLDS CONNECTING THE TWO BANKS OF FILTERS.
3. LOADING THE AS-741 FILTER MEDIA INTO THE FILTER VESSELS(2 EACH 2,250# BULK BAGS PER VESSEL.
4. CONNECTING POWER SUPPLY TO FILTER BACKWASH CONTROLLER(120 VAC, SWITCHED CIRCUIT).



NOTE:
DIMENSIONS GIVEN WILL VARY DUE TO FABRICATION TOLERANCES

ATEC SYSTEMS
1329 BROADWAY STREET, SUITE 206, P.O. BOX 518
LONGVIEW, WASHINGTON 98632
PHONE: (360) 414-9223 FAX: (360) 397-0375

DESIGN BY:	.
DRAWN BY:	.
CHECKED BY:	.
APR'D BY:	.

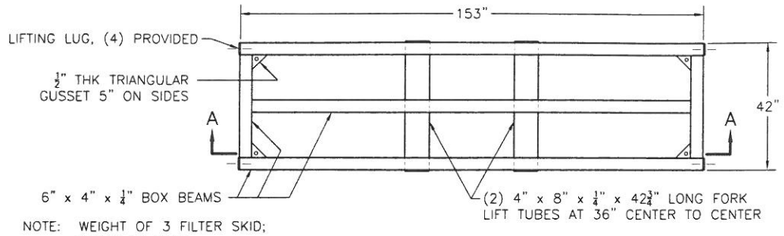
NO.	DATE		BY	APVD

0 2 4
SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1/2" = 1'-0"
SCALEABLE IN 11x17 - 1/4" = 1'-0"

Arsenic Treatment System
City of Live Oak
Well 4

FILTER DETAILS

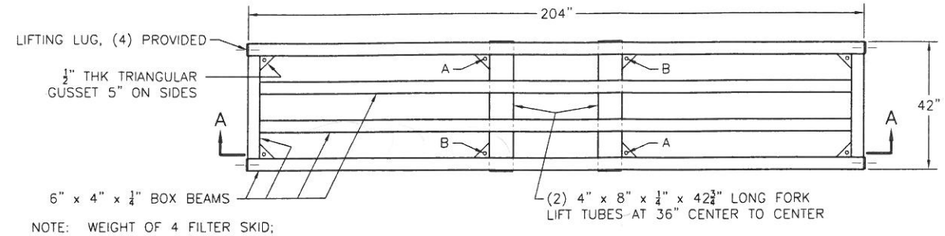
SHEET NO.	1 of 2
DWG. NO.	
DATE:	08.30.07
FILE:	LiveOak . dwg



NOTE: WEIGHT OF 3 FILTER SKID;
EMPTY 11,400#
WITH MEDIA AND WATER 36,000#

3 FILTER SKID
(2 REQUIRED)

0 2 4
SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1/2" = 1'-0"



NOTE: WEIGHT OF 4 FILTER SKID;
EMPTY 15,200#
WITH MEDIA AND WATER 48,000#

4 FILTER SKID
(2 REQUIRED)

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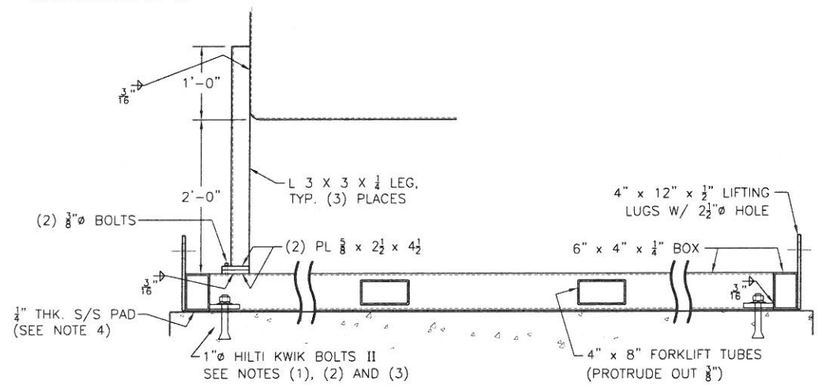
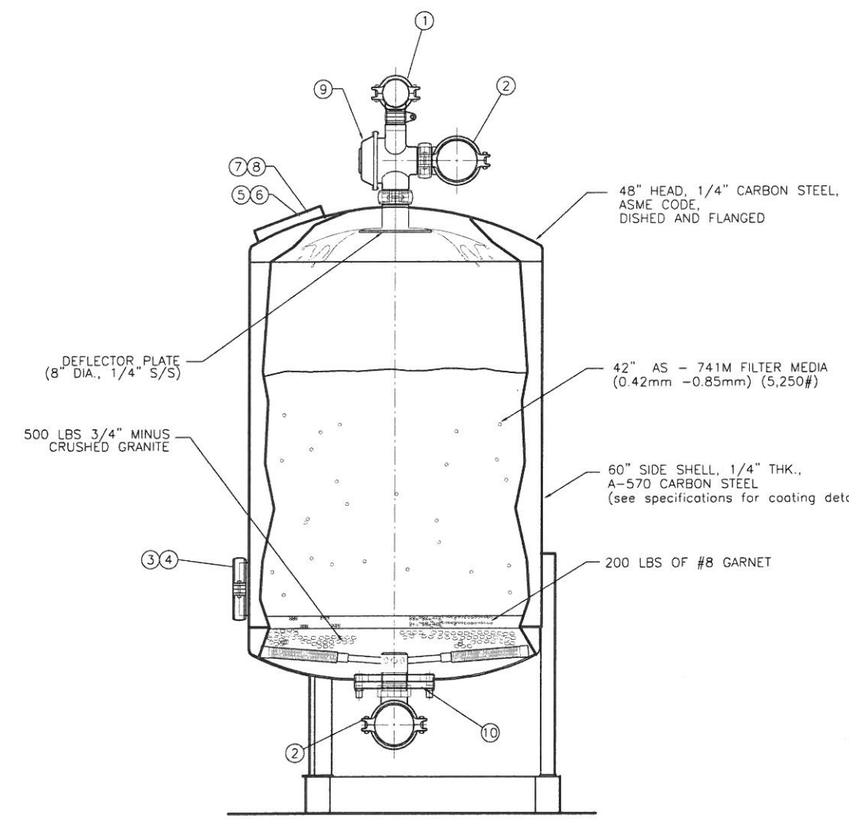
SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1/2" = 1'-0"



SECTION A–A
SCALE 1" = 1'-0"

0 1 2
SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1" = 1'-0"



BILL OF MATERIAL			
ITEM	QTY	PART NO.	DESCRIPTION
1	1	PFS–CPL03	3" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
2	3	PFS–CPL04	4" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
3	1	PFS–CAP08	8" GROOVED END CAP
4	1	PFS–CPL08	8" GROOVED COUPLING, CAST IRON W/ BOLTS & NUTS
5	1	PFS=HHP11	11"x15" HAND HOLE PLATE
6	1	PFS–HHG11	11"x15" HAND HOLE GASKET
7	1	PFS–HHGS11	11"x15" HAND HOLE BOLT SET
8	1	PFS–HHCR11	11"x15" HAND HOLE HOLD DOWN CRAB
9	1	V–BF4	4"x4"x3" SERIES 350 BERMAD BACKWASH VALVE
10	1	UA SS48	UNDER–DRAIN ASSEMBLY 316L SS W/ SCH 80 PVC CAP COMPLETE

NOTE: QUANTITIES FOR ONE (1) TANK

NOTES:

(1) DESIGNER SHALL DETERMINE NO. AND DEPTH OF ANCHOR BOLTS TO SUIT LOCAL CODE REQUIREMENTS. FOUR BOLTS ARE REQUIRED AS A MINIMUM AT EXTERIOR GUSSETS.

(2) ANCHOR BOLT HOLES ARE TO BE DRILLED INTO CONCRETE FOUNDATION THROUGH OVERSIZED DRILL HOLES IN GUSSETS IN SKID ASSEMBLY BY INSTALLATION CONTRACTOR.

(3) IF LESS THAN 8 BOLTS ARE SPECIFIED FOR 4 AND 5 FILTER SKIDS, MIDDLE BOLTS SHALL BE AT LOCATIONS "A" OR "B" (DIAGONAL FROM EACH OTHER)

(4) 1/4" THICK S/S PADS ARE PROVIDED UNDER SKIDS FOR CLEARANCE BETWEEN SKIDS AND CONCRETE FOUNDATION. SIX PADS ARE PROVIDED FOR 2 & 3 FILTER SKIDS, EIGHT PADS FOR 3–14 FILTER SKIDS

ATEC SYSTEMS
1329 BROADWAY STREET, SUITE 206, P.O. BOX 518
LONGVIEW, WASHINGTON 98632
PHONE: (360) 414-9223 FAX: (360) 397-0375

DESIGN BY:
DRAWN BY:
CHECKED BY:
APR'D BY:

NO.	DATE		BY	APVD

0 1 2 4
SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1/2" = 1'-0"
SCALEABLE IN 11x17 - 1/4" = 1'-0"

Arsenic Treatment System
City of Live Oak
Well 4

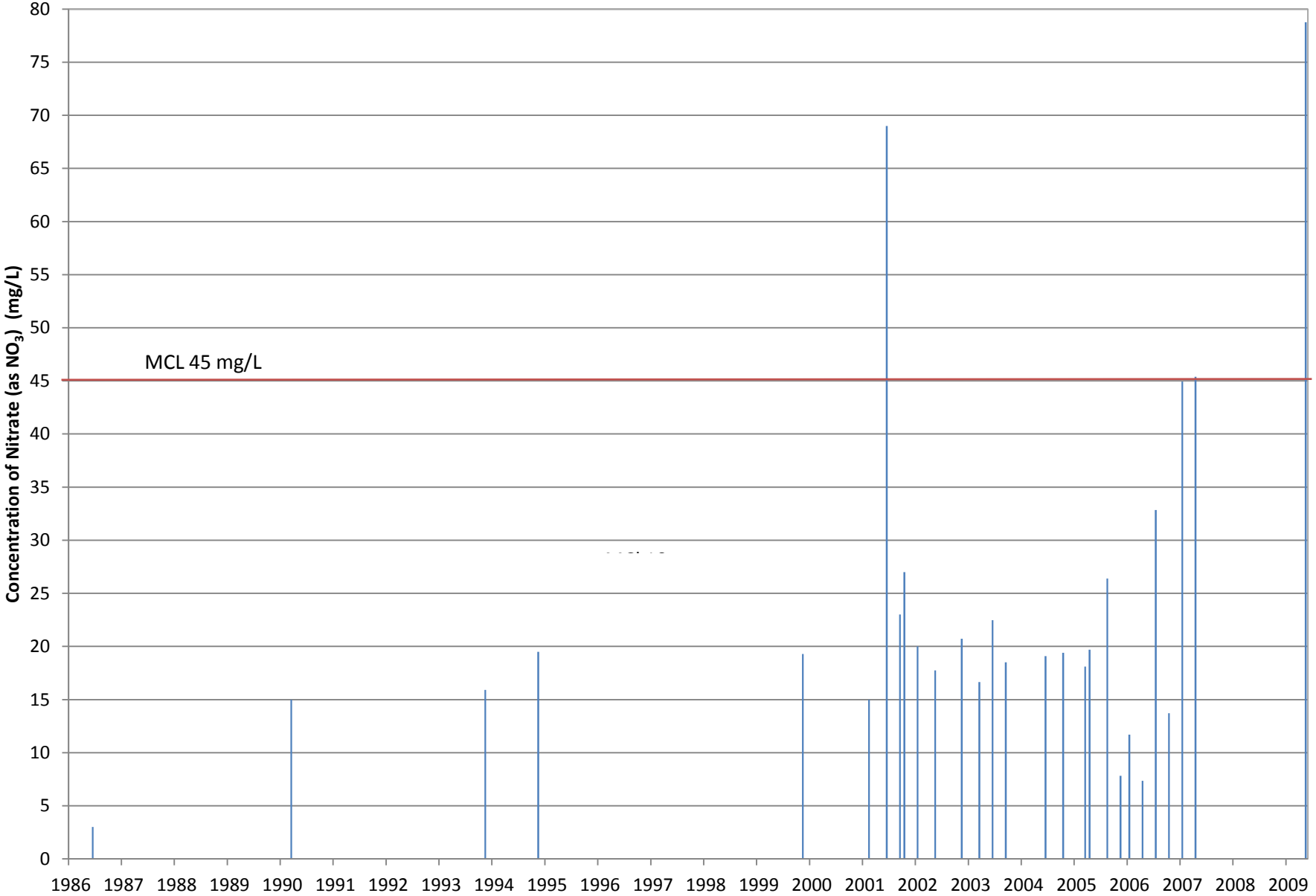
FILTER DETAILS

SHEET NO. 2 of 2
DWG. NO.
DATE: 08.30.07
FILE: LiveOak . dwg

> "Nitrate is a contaminant which does not naturally occur in the subsurface. Elevated concentrations of nitrate are widespread in the Sacramento Valley. Concentrations of nitrate in the populated areas of Sutter County are near or above the MCL for nitrate (as NO_3). The CDPH has established a primary MCL of 45 milligrams per liter (mg/L) for nitrate (as NO_3). Near the Sutter Buttes and Yuba City, nitrate concentrations in several wells (less than 150 feet) exceed the MCL. Where present, elevated concentrations of nitrate are likely a result of overlying land uses, such as septic systems, animal enclosures, or applied fertilizers." (pages 31-32)

Nitrate (as NO_3) concentration measured at Well #5 is summarized on Figure 4 and shows an average nitrate concentration of 27.7 mg/L. The City of Live Oak Consumer Confidence Report from 2009, the same year that Well #5 was abandoned, identified a city-wide nitrate concentration of 21.25 mg/L. The 2013 Consumer Confidence Report for the City reported a nitrate concentration of 4.97 mg/L for the existing operational wells (Wells #1A, 2A, 3, and 4), and nitrate concentrations for new wells, like this Water Supply Reliability Well Project, are expected to be similar or lower. Well design criteria, such as increasing drilling depth, carefully selecting the well location, and selectively screening for intervals of optimal water quality will be used to help ensure new wells will help reduce nitrate content.

Figure 4: Historical Nitrate (as NO_3) Concentrations for Well #5



Cost Effectiveness Analysis

Table 6 – Cost Effective Analysis Project name: _Water Supply Reliability Well_____	
Question 1	Types of benefits provided as shown in Table 5 1. New Water Supply Production 2. Drinking Water Treatment (Arsenic) 3. Lower Nitrate Concentration at New Well Facilities
Question 2	Have alternative methods been considered to achieve the same types and amounts of physical benefits as the proposed project been identified? No.
	If no, why? The City of Live Oak has no other cost effective alternatives for additional water supply other than replacement well facilities for abandoned Well #5. The City does not have an available surface water supply to serve its customers and it is cost prohibitive to consider development of surface supply at this time. Compared to the City's existing wells, the new well facilities will be constructed with stainless steel wire wrap for the screen and be equipped with a vertical turbine pump with a variable frequency drive. This proposed new well design will result in lower operation and maintenance cost and have lower energy requirements over the life of the well compared to the City's existing wells.
	If yes, list the methods (including the proposed project) and estimated costs.
Question 3	If the proposed project is not the least cost alternative, why is it the preferred alternative? Provide an explanation of any accomplishments of the proposed project that are different from the alternative project or methods. The proposed project is the least cost alternative.
Comments:	

Attachment 3: Project Justification

Attached Reference Documents

2009 City of Live Oak Consumer Confidence Report

2013 City of Live Oak Consumer Confidence Report

2009 City of Live Oak Draft Urban Water Management Plan

2012 Sutter County Groundwater Management Plan

2009 City of Live Oak Water Master Plan

2009 Consumer Confidence Report

Water System Name: **City of Live Oak 5110001** Report Date: 5-28-2010

We test the drinking water quality for many constituents as required by state and federal regulations. This report shows the results of our monitoring for the period of January 1 - December 31, 2009.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo ó hable con alguien que lo entienda bien.

ਇਹ ਸੂਚਨਾ ਮਹਤੱਵਪੂਰਣ ਹੈ।
ਕ੍ਰਿਪਾ ਕਰਕੇ ਕਿਸੀ ਤੋਂ ਇਸ ਦਾ ਅਨੁਵਾਦ ਕਰਾਉ।

Type of water source(s) in use: Wells (ground water).

Name & location of source(s): Wells 1a, 2a, 3, and 4.

Drinking Water Source Assessment information: A source assessment has been completed for the four wells serving the City of Live Oak. The sources are considered most vulnerable to the following activities not associated with any detected contaminants:
Wells 1a, 2a, and 3: Existing and historic gas stations, underground storage tanks.
Well 4 Agricultural drainage, chemical / petroleum pipelines sewer collection systems, existing / historic gas stations, chemical / petroleum processing / storage, underground storage tanks. To view the complete assessment contact:

DHS Valley District Office
415 Knollcrest Drive, Suite 110
Redding, Ca. 96002
Attn: Richard Hinrichs 224-4867

Or at: Live Oak City Hall
9955 Live Oak Blvd.
Live Oak, CA 95953
Attn: Jim Goodwin (530) 695-2112

Time and place of regularly scheduled board meetings for public participation:
City Hall, 9955 Live Oak Blvd. First and third Wednesday of every month at 7 PM.

For more information, contact: Jim Goodwin City Manager Phone: (530) 695-2112

TERMS USED IN THIS REPORT

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the PHGs (or MCLGs) as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste, and appearance of drinking water.

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency (USEPA).

Public Health Goal (PHG): The level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.

Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Primary Drinking Water Standards (PDWS): MCLs and MRDLs for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.

Secondary Drinking Water Standards (SDWS): MCLs for contaminants that affect taste, odor, or appearance of the drinking water. Contaminants with SDWSs do not affect the health at the MCL levels.

Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

Regulatory Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

Variances and Exemptions: Department permission to exceed an MCL or not comply with a treatment technique under certain conditions.

ND: not detectable at testing limit

ppm: parts per million or milligrams per liter (mg/L)

ppb: parts per billion or micrograms per liter (ug/L)

ppt: parts per trillion or nanograms per liter (ng/L)

ppq: parts per quadrillion or picogram per liter (pg/L)

pCi/L: picocuries per liter (a measure of radiation)

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- *Microbial contaminants*, such as viruses and bacteria that may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- *Inorganic contaminants*, such as salts and metals that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- *Pesticides and herbicides*, that may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
- *Organic chemical contaminants*, including synthetic and volatile organic chemicals, that are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, agricultural application, and septic systems.
- *Radioactive contaminants*, that can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the USEPA and the state Department of Public Health (Department) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that provide the same protection for public health.

Tables 1, 2, 3, 4, and 5 list all of the drinking water contaminants that were detected during the most recent sampling for the constituent. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. The Department allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of the data, though representative of the water quality, are more than one year old.

TABLE 1 – SAMPLING RESULTS SHOWING THE DETECTION OF COLIFORM BACTERIA

Microbiological Contaminants (complete if bacteria detected)	**Highest No. of Detections**	**No. of months in violation**	**MCL**	**MCLG**	**Typical Source of Bacteria**
Total Coliform Bacteria	(In a mo.) 0	0	More than 1 sample in a month with a detection	0	Naturally present in the environment
Fecal Coliform or *E. coli*	(In the year) 0	0	A routine sample and a repeat sample detect total coliform and either sample also detects fecal coliform or *E. coli*	0	Human and animal fecal waste

TABLE 2 – SAMPLING RESULTS SHOWING THE DETECTION OF LEAD AND COPPER

Lead and Copper (complete if lead or copper detected in the last sample set)	**No. of samples collected**	**90th percentile level detected**	**No. sites exceeding AL**	**AL**	**PHG**	**Typical Source of Contaminant**
Lead (ppb) Sept., Oct. 2008	20	ND	0	15	2	Internal corrosion of household water plumbing systems; discharges from industrial manufacturers; erosion of natural deposits
Copper (ppm) Sept., Oct. 2008	20	0.17	0	1.3	0.17	Internal corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives

TABLE 3 – SAMPLING RESULTS FOR SODIUM AND HARDNESS

Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL**	**PHG (MCLG)**	**Typical Source of Contaminant**
Sodium (ppm)	2003,05,06	18.8	16-20	none	none	Salt present in the water and is generally naturally occurring
Hardness (ppm) Grains	2005,06	215 12.6	167-251 9.8-14.7	none	none	Sum of polyvalent cations present in the water, generally magnesium and calcium, and are usually naturally occurring

Any violation of an MC or AL is asterisked. Additional information regarding the violation is provided later in this report.

TABLE 4 – DETECTION OF CONTAMINANTS WITH A PRIMARY DRINKING WATER STANDARD						
Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL [MRDL]**	**PHG (MCLG) [MRDLG]**	**Typical Source of Contaminant**
Arsenic Treated water (ppb)	2009	4.6	ND-9.7	10	0.004	Erosion of natural deposits, runoff from orchards. Some people who drink water that contains arsenic in excess of the MCL over many years could experience skim damage or problems with their circulatory system, and may have an increased risk of getting cancer.
Chlorine (ppm)	3 per week	1.07	0.21-2.20	4	4	Drinking water disinfectant added for treatment.
Chromium (ppb)	2007, 08,09	6.5	ND-15	50	100	Discharge from steel and pulp mills and chrome plating; erosion of natural deposits.
Fluoride (ppm)	2006, 07, 08	0.20	0.19-0.21	2	1	Erosion of natural deposits; water additive which promotes strong teeth; discharge from fertilizer and aluminum factories.
Nitrate (ppm)	2009	21.25	11.48-23.25	45	45	Runoff and leaching from fertilizer use; leaching from septic tanks and sewage; erosion of natural deposits.

TABLE 5 – DETECTION OF CONTAMINANTS WITH A SECONDARY DRINKING WATER STANDARD						
Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL**	**PHG (MCLG)**	**Typical Source of Contaminant**
Chloride (ppm)	2008,09	9.9	7.2-12.6	500	n/a	Runoff/leaching from natural deposits; saltwater influence.
Manganese (ppb)	2006,07 ,09	19.5	ND-34.0	50	n/a	Leaching from natural deposits.
Sulfate (ppm)	2007, 08,09	21.1	17.2-25.3	500	n/a	Runoff/ leaching of natural deposits; industrial wastes.
Total Dissolved Solids (ppm)	2005, 06	318	242-380	1000	n/a	Runoff/ leaching of natural deposits.
Turbidity (NTUs)	2005, 08,09	1.3	0.30-1.90	5	n/a	Soil runoff.

TABLE 6 – DETECTION OF UNREGULATED CONTAMINANTS					
Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**Notification Level**	**Health Effects Language**
Hexavalent Chrome (ppb)	2006	4.4	ND-8.8	n/a	Hexavalent Chrome (ppb)

***Any violation of an MCL, MRDL, or TT is asterisked. Additional information regarding the violation is provided later in this report.*

Additional General Information on Drinking Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline (1-800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline (1-800-426-4791).

In order to ensure that tap water is safe to drink, the U.S. Environmental Protection Agency (USEPA) and the State Department of Public Health (Department) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that provide the same

- *If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. City of Live Oak is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.*

While your drinking water meets the federal and state standard for arsenic, it does contain low levels of arsenic. The arsenic standard balances the current understanding of arsenic's possible health effects against the costs of removing arsenic from drinking water. The U.S. Environmental Protection Agency continues to research the health effects of low levels of arsenic, which is a mineral known to cause cancer in humans at high concentrations and is linked to other health effects such as skin damage and circulatory problems.

Nitrate in drinking water at levels above 45 mg/L is a health risk for infants of less than six months of age. Such nitrate levels in drinking water can interfere with the capacity of the infant's blood to carry oxygen, resulting in a serious illness; symptoms include shortness of breath and blueness of the skin. Nitrate levels above 45 mg/L may also affect the ability of the blood to carry oxygen in other individuals, such as pregnant women and those with certain specific enzyme deficiencies. If you are caring for an infant, or you are pregnant, you should ask advice from your health care provider.

Nitrate levels may rise quickly for short periods of time because of rainfall or agricultural activity.

Summary Information for Contaminants Exceeding an MCL, MRDL, or AL or Violation of Any TT or Monitoring and Reporting Requirement

Last year your tap water met all EPA and State drinking water health standards. The City of Live Oak's Public Works Department vigilantly safeguards your water supplies and now meets the State and Federal drinking water standards for arsenic treatment contaminate levels as of January 2009.

Summary Information for Fecal Indicator-Positive Ground Water Source Samples, Uncorrected Significant Deficiencies, or Violation of a Ground Water TT

We had no Fecal Indicator-Positive Ground Water Source Samples in 2009.

2013 Consumer Confidence Report

Water System Name: **City of Live Oak 5110001** Report Date: July 1st 2014

We test the drinking water quality for many constituents as required by state and federal regulations. This report shows the results of our monitoring for the period of January 1 - December 31, 2012 and may include earlier monitoring data.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo ó hable con alguien que lo entienda bien.

ਇਹ ਸੂਚਨਾ ਮਹਤੱਵਪੂਰਣ ਹੈ।
ਕ੍ਰਿਪਾ ਕਰਕੇ ਕਿਸੀ ਤੋ ਇਸ ਦਾ ਅਨੁਵਾਦ ਕਰਾਉ।

Type of water source(s) in use: Wells

Name & location of source(s): Well 1a & Well 2A 10046 O Street. Well Three 2455 Walker Way. Well Four 2658 Apricot Street

Drinking Water Source Assessment information: A source assessment has been completed for the four well sites Serving the City of Live Oak. Wells 1a/2a and 3: Existing and historic gas station, underground storage tanks. Well 4: Agricultural drainage, chemical/petroleum pipelines, sewer collection system, existing/historic gas station, Chemical/petroleum processing/storage, underground storage tanks

Time and place of regularly scheduled board meetings for public participation: City Hall, 9955 Live Oak Blvd. first and third Wednesday of every month at 7 PM

For more information, contact: City Manager Jim Goodwin Phone: 530-695-2112

TERMS USED IN THIS REPORT

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the PHGs (or MCLGs) as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste, and appearance of drinking water.

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency (USEPA).

Public Health Goal (PHG): The level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.

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Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use

Primary Drinking Water Standards (PDWS): MCLs and MRDLs for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.

Secondary Drinking Water Standards (SDWS): MCLs for contaminants that affect taste, odor, or appearance of the drinking water. Contaminants with SDWSs do not affect the health at the MCL levels.

Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

Regulatory Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

Variances and Exemptions: Department permission to exceed an MCL or not comply with a treatment technique under certain conditions.

ND: not detectable at testing limit

ppm: parts per million or milligrams per liter (mg/L)

ppb: parts per billion or micrograms per liter (µg/L)

ppt: parts per trillion or nanograms per liter (ng/L)

ppq: parts per quadrillion or picogram per liter (pg/L)

of disinfectants to control microbial contaminants.	**pCi/L**: picocuries per liter (a measure of radiation)

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- *Microbial contaminants*, such as viruses and bacteria, that may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- *Inorganic contaminants*, such as salts and metals, that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- *Pesticides and herbicides*, that may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
- *Organic chemical contaminants*, including synthetic and volatile organic chemicals, that are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, agricultural application, and septic systems.
- *Radioactive contaminants*, that can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the USEPA and the California Department of Public Health (Department) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. Department regulations also establish limits for contaminants in bottled water that provide the same protection for public health.

Tables 1, 2, 3, 4, 5, 7, and 8 list all of the drinking water contaminants that were detected during the most recent sampling for the constituent. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. The Department allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants do not change frequently. Some of the data, though representative of the water quality, are more than one year old.

TABLE 1 – SAMPLING RESULTS SHOWING THE DETECTION OF COLIFORM BACTERIA

Microbiological Contaminants (complete if bacteria detected)	**Highest No. of Detections**	**No. of months in violation**	**MCL**	**MCLG**	**Typical Source of Bacteria**
Total Coliform Bacteria	(In a mo.)	0	More than 1 sample in a month with a detection	0	Naturally present in the environment
Fecal Coliform or *E. coli*	(In the year)	0	A routine sample and a repeat sample detect total coliform and either sample also detects fecal coliform or *E. coli*	0	Human and animal fecal waste

TABLE 2 – SAMPLING RESULTS SHOWING THE DETECTION OF LEAD AND COPPER

Lead and Copper (complete if lead or copper detected in the last sample set)	**No. of samples collected**	**90th percentile level detected**	**No. sites exceeding AL**	**AL**	**PHG**	**Typical Source of Contaminant**
Lead (ppb) August 2011	20	0.0013	0	15	0.2	Internal corrosion of household water plumbing systems; discharges from industrial manufacturers; erosion of natural deposits
Copper (ppm) August 2011	18	0.176	0	1.3	0.3	Internal corrosion of household plumbing systems; erosion of natural deposits;

						leaching from wood preservatives

TABLE 3 – SAMPLING RESULTS FOR SODIUM AND HARDNESS

Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL**	**PHG (MCLG)**	**Typical Source of Contaminant**
Sodium (ppm)	2012	18 mg/l	18 mg/l	none	none	Salt present in the water and is generally naturally occurring
Hardness (ppm)	2006	214 mg/l	201-240 mg/l	none	none	Sum of polyvalent cations present in the water, generally magnesium and calcium, and are usually naturally occurring

***Any violation of an MCL or AL is asterisked. Additional information regarding the violation is provided later in this report.*

While your drinking water meets the federal and state standard for arsenic, it does contain low levels of arsenic. The arsenic standard balances the current understanding of arsenic's possible health effects against the costs of removing arsenic from drinking water. The U.S. Environmental Protection Agency continues to research the health effects of low levels of arsenic, which is a mineral known to cause cancer in humans at high concentrations and is linked to other health effects such as skin damage and circulatory problems.

TABLE 4 – DETECTION OF CONTAMINANTS WITH A PRIMARY DRINKING WATER STANDARD

Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL [MRDL]**	**PHG (MCLG) [MRDLG]**	**Typical Source of Contaminant**
Arsenic	2013	4.7	ND-9.8 ug/l	10 ug/l	0.004 ug/l	Some people who drink water containing arsenic in excess of the MCL over many years may experience skin damage or circulatory system problems, and may have an increased risk of getting cancer.
Barium	2012	140 ug/l	140 ug/l	1,000.0 ug/l	2000 ug/l	Some people who drink water containing barium in excess of the MCL over many years may experience an increase in blood pressure.
Chromium	2012	11.0 ug/l	11 ug/l	50.0 ug/l	(100)	Some people who use water containing chromium in excess of the MCL over many years may experience allergic dermatitis.
Fluoride (natural source)	2012	0.1440 mg/l	0.1440 mg/L	2.0 mg/l	1.0 mg/l	*For the Consumer Confidence Report:* Some people who drink water containing fluoride in excess of the federal MCL of 4 mg/L over many years may get bone disease, including pain and tenderness of the bones. Children who drink water containing fluoride in excess of the state MCL of 2 mg/L may get mottled teeth. *For a Public Notice:* This is an alert about your drinking water and a cosmetic dental problem that might affect children under nine years of age. At low levels, fluoride can help prevent cavities, but children drinking

						water containing more than 2 milligrams per liter (mg/L) of fluoride may develop cosmetic discoloration of their permanent teeth (dental fluorosis). The drinking water provided by your community water system [*name*] has a fluoride concentration of [*insert value*] mg/L. Dental fluorosis may result in a brown staining and/or pitting of the permanent teeth. This problem occurs only in developing teeth, before they erupt from the gums. Children under nine should be provided with alternative sources of drinking water or water that has been treated to remove the fluoride to avoid the possibility of staining and pitting of their permanent teeth. You may also want to contact your dentist about proper use by young children of fluoride-containing products. Older children and adults may safely drink the water. Drinking water containing more than 4 mg/L of fluoride can increase your risk of developing bone disease. For more information, please call [*water system contact name*] of [*water system name*] at [*phone number*]. Some home water treatment units are also available to remove fluoride from drinking water. To learn more about available home water treatment units, you may call the California Department of Public Health's Water Treatment Device Unit at (916) 449-5600.
Nitrate	2013	4.97 mg/l	1.29-6.94 mg/l	45 mg/l (as NO3)	45 mg/l (as NO3)	Infants below the age of six months who drink water containing nitrite in excess of the MCL may become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blueness of the skin.
Carbofuran	2013	ND ug/l		18.00 ug/l	1.7 ug/l	Some people who use water containing Carbofuran in excess of the MCL over many years may experience problems with their blood, or nervous or reproductive system problems.
2,4,-D	2012	10 ug/l	10 ug/l	70 ug/l	20 ug/l	Some people who use water containing the weed killer 2,4-D in excess of the MCL over many years may experience kidney, liver, or adrenal gland problems.

Dibromochloropropane (DBCP)	2012	0.017 ug/l	0.01-0.024 ug/l	5.0 ug/l	4.0 ug/l	Some people who use water containing DBCP in excess of the MCL over many years may experience reproductive difficulties and may have an increased risk of getting cancer.
DI (2-Ethylhexyl)Adipate	2010	5.0 ug/l		400.0 ug/l	200 ug/l	Some people who drink water containing di(2-ethylhexyl) adipate in excess of the MCL over many years may experience weight loss, liver enlargement, or possible reproductive difficulties.
DI (2-Ethylhexyl) Phthalate	2010	3.0 ug/l		4.0 ug/l	12.0 ug/l	Some people who use water containing di(2-ethylhexyl) phthalate well in excess of the MCL over many years may experience liver problems or reproductive difficulties, and may have an increased risk of getting cancer.
Ethylene Dibromide (EDB)	2012	0.02 ug/l		0.05 ug/l	0.01 ug/l	Some people who use water containing ethylene Dibromide in excess of the MCL over many years may experience liver, stomach, reproductive system, or kidney problems, and may have an increased risk of getting cancer.
Glyphosate	2013	25ug/l		700.0 ug/l	900 ug/l	Some people who drink water containing glyphosate in excess of the MCL over many years may experience kidney problems or reproductive difficulties.
Molinate	2013	2.ug/l		20.0 ug/l	1.0 ug/l	Some people who use water containing Molinate in excess of the MCL over many years may experience reproductive effects.
Simazine	2013	1.0 ug/l		4.0 ug/l	4.0 ug/l	Some people who use water containing Simazine in excess of the MCL over many years may experience blood problems.
Oxamyl	2012	20 ug/l		50.0 ug/l	26.0 ug/l	Some people who drink water containing Oxamyl in excess of the MCL over many years may experience slight nervous system effects.
Atrazine	2013	ND ug/l		1.0 ug/l	0.15 ug/l	Some people who use water containing atrazine in excess of the MCL over many years may experience cardiovascular system problems or reproductive difficulties.
Hexachlorocyclopentadiene	2010	1.0 ug/l		50.0 ug/l	50.0 ug/l	Some people who use water containing Hexachlorocyclopentadiene in excess of the MCL over many years may experience kidney or stomach problems.
Hexachlorobenzene	2010	1.0 ug/l		1.0 ug/l	0.5 ug/l	Some people who drink water containing Hexachlorobenzene in excess of the MCL over many years may experience liver or kidney problems, or adverse reproductive effects, and may have an increased risk of getting cancer.

Xylenes	2013	ND ug/l	ND	10 mg/l	10mg/l	Some people who drink water containing xylenes well in excess of the maximum contaminant level (MCL) for many years could experience damage to their nervous system.
Benzo (A) Pyrene	2010	0.1 ug/l		0.2 ug/l	.07 ug/l	Leaching from linings of water storage tanks and distribution mains
TABLE 5 – DETECTION OF CONTAMINANTS WITH A SECONDARY DRINKING WATER STANDARD						
Chemical or Constituent (and reporting units)	**Sample Date**	**Level Detected**	**Range of Detections**	**MCL**	**PHG (MCLG)**	Typical Source of Contaminant
Copper	2012	ND ug/l		1,000 ug/l	N/A	Copper is an essential nutrient, but some people who drink water containing copper in excess of the action level over a relatively short amount of time may experience gastrointestinal distress. Some people who drink water containing copper in excess of the action level over many years may suffer liver or kidney damage. People with Wilson's Disease should consult their personal doctor.
Color	2012	1.0 units		15.0 units	N/A	Naturally-occurring organic materials
Iron	2012	194.4 ug/l	193-196 ug/l	300 ug/l	N/A	Naturally-occurring organic materials
Manganese	2013	5-590 ug/l	5-590 ug/l	50.0 ug/l	N/A	Leaching from natural deposits
Specific Conductance	2013	510 US	510 US	2,200 US	N/A	Leaching from natural deposits; industrial wastes
Turbidity		NTU 0.5		5.0 NTU	N/A	Turbidity has no health effects. However, high levels of turbidity can interfere with disinfection and provide a medium for microbial growth. Turbidity may indicate the presence of disease-causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.
Odor Threshold	2012	0.0 TON		3.0 TON	N/A	Substances that form ions when in water; seawater influence
Thiobencarb	2013	1.0 ug/l	1.0 ug/l	70.0 ug/l	70.0 ug/l	Some people who use water containing Thiobencarb in excess of the MCL over many years may experience body weight and blood effects.

Additional General Information on Drinking Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline (1-800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline (1-800-426-4791).

Lead-Specific Language for Community Water Systems: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. City of Live Oak is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Summary Information for Violation of a MCL, MRDL, AL, TT, or Monitoring and Reporting Requirement

VIOLATION OF A MCL, MRDL, AL, TT, OR MONITORING AND REPORTING REQUIREMENT				
Violation	**Explanation**	**Duration**	**Actions Taken to Correct the Violation**	**Health Effects Language**
No violations in 2013				

For Water Systems Providing Ground Water as a Source of Drinking Water

TABLE 7 – SAMPLING RESULTS SHOWING FECAL INDICATOR-POSITIVE GROUND WATER SOURCE SAMPLES					
Microbiological Contaminants (complete if fecal-indicator detected)	**Total No. of Detections**	**Sample Dates**	**MCL [MRDL]**	**PHG (MCLG) [MRDLG]**	**Typical Source of Contaminant**
E. coli	2013 ND		0	(0)	Human and animal fecal waste
Enterococci	2013 ND		TT	n/a	Human and animal fecal waste

Coliphage	2012 ND		TT	n/a	Human and animal fecal waste

Summary Information for Fecal Indicator-Positive Ground Water Source Samples, Uncorrected Significant Deficiencies, or Ground Water TT

SPECIAL NOTICE OF FECAL INDICATOR-POSITIVE GROUND WATER SOURCE SAMPLE

SPECIAL NOTICE FOR UNCORRECTED SIGNIFICANT DEFICIENCIES

VIOLATION OF GROUND WATER TT				
TT Violation	**Explanation**	**Duration**	**Actions Taken to Correct the Violation**	**Health Effects Language**

CITY OF LIVE OAK

City of Live Oak
Urban Water Management Plan

DRAFT

October 2009

Prepared for
City of Live Oak

Prepared by
ECO:LOGIC
ENGINEERS · CONSULTANTS

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Appendix C Resolution of Adoption of City of Live Oak Urban Water Management Plan

Section 1

Introduction

The City of Live Oak prepared this Urban Water Management Plan (UWMP) in 2009. This plan includes information necessary to meet the requirements of the California Water Code Division 6, Part 2.6 (Urban Water Management Planning Act), with guidance from the California Department of Water Resources document Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan.

Although the City of Live Oak is not currently subject to the Urban Water Management Planning Act (i.e., the City produces less than 3,000 acre feet of water per year and serves less than 3,000 customers or connections), this plan has been prepared to be used in meeting the requirements of SB610 and SB221. This Urban Water Management Plan is intended to be used in conjunction with the Water Master Plan to fulfill the requirements of water supply assessments and verifications.

1.1 CONTACT

The water supplier is a Municipality, and is not a Bureau of Reclamation Contractor or State Water Project Contractor.

The person to contact regarding this Urban Water Management Plan is:

Public Works Facilities Manager
9955 Live Oak Boulevard
Live Oak, CA 95953
Phone: (530) 695-2112
Fax: (530) 695-2595
E-mail addresses: srolls@rarcivil.com and stakhar@liveoakcity.org

1.2 PURPOSE

This report has been prepared in anticipation of meeting the requirements of the Urban Water Management Plan Act (UWMPA), Water Code Section 10630 et. seq. The City has also prepared this plan to promote the managed use of water for urban and municipal purposes. The purpose of the UWMP is to develop and promote water conservation tools and to plan for potential water shortages. A second purpose for the City preparing this UWMP is to prepare for water supply assessments and verifications that may be necessary according to SB 610 and SB221 for future planned development consistent with the City's General Plan.

The programs and water management tools developed from the UWMPA will help to secure future water resources for the City of Live Oak and to maximize the beneficial use of current sources.

1.3 PUBLIC PARTICIPATION

1.3.1 AGENCY COORDINATION

This UWMP is consistent with growth projections and land use designations contained in the City's 2009 General Plan (General Plan). This document has also been coordinated with the City's Water Master Plan.

1.3.2 INTERAGENCY COORDINATION

The City of Live Oak draws groundwater from a basin that is shared by other water purveyors. Several local and regional stakeholders were solicited for assistance in the draft of this plan (Table 1-1).

The City notified the following entities about the plan:

Table 1-1
Summary of Coordination Efforts to Include Agencies and Citizens in Planning and Notification

Coordination and Public Involvement Actions						
Entities	**Plan Writing**	**Contacted**	**Attended Meeting**	**Given Copy**	**Comments Received**	**Noticed of Adoption**
Consultant						
City of Live Oak						
Residential						
Commercial						
Industrial						
Yuba City						
Gridley						
Biggs						
Sutter County						
Library						

Will be filled in at the time of implementation.

1.4 IMPLEMENTATION OF UWMP

This Urban Water Management Plan is the first plan prepared by the City. The demand management measures will be implemented under the following circumstances:

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or;
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Budget costs will be estimated at the time of implementation.

Section 2

Supplier Service Area

2.1 SERVICE AREA

The City of Live Oak is located on the northern edge of Sutter County north of Yuba City. The City supplies potable water to all the residential, commercial, and institutional / governmental water users within City limits.

2.2 CLIMATE

Live Oak has a mild climate with hot and dry summers, and cool winters (Table 2-1). Annual precipitation averages approximately 21 inches. Deviation from the average annual precipitation was experienced in 1995-98 due to the El Nino conditions when considerably more precipitation than average occurred, and the last drought period extended from 1987 to 1991.

Table 2-1
Average Monthly Climate Conditions of the Live Oak Region

Month	Monthly Average E_{to} (in)	Average Rainfall (in)	Average Temp (^oF)
Jan	1.00	4.36	46.06
Feb	1.66	3.52	51.40
Mar	3.12	2.91	55.31
Apr	4.72	1.60	60.80
May	6.07	0.67	67.69
June	7.45	0.23	74.47
July	8.46	0.04	79.21
Aug	7.62	0.08	77.47
Sept	5.70	0.33	73.50
Oct	4.06	1.32	65.25
Nov	1.97	2.81	53.95
Dec	1.07	3.61	46.72
Annual	4.41	21.48	62.65

Source: NOAA and CIMIS

www.wrcc.dri.edu/CLIMATEDATA.html

www.cimis.water.ca.gov/cimis/welcome.jsp

2.3 OTHER DEMOGRAPHIC FACTORS

Live Oak was incorporated as a City in 1947. The City lies along Highway 99, and west of the Feather River as depicted in Figure 2-1. The City is predominately surrounded by agricultural land. The topography is relatively flat with an average elevation of approximately 77 feet above mean sea level (NAVD 88).

2.3.1 POPULATION GROWTH

The City's annual population growth rate has varied widely during the past decade. From 1990 to 2000, the population increased by approximately 1,900 residents per the State of California, Department of Finance.[1] As the overall population has increased in the City and region, the demand for water has also increased. For purposes of this plan, the City has a future projected average population growth rate of 4.8% growth rate based on historical growth data from 2001 through 2008.[2] Table 2-2 summarizes the projected population growth of the City to the year 2030.

Table 2-2
Population Projections of the City of Live Oak

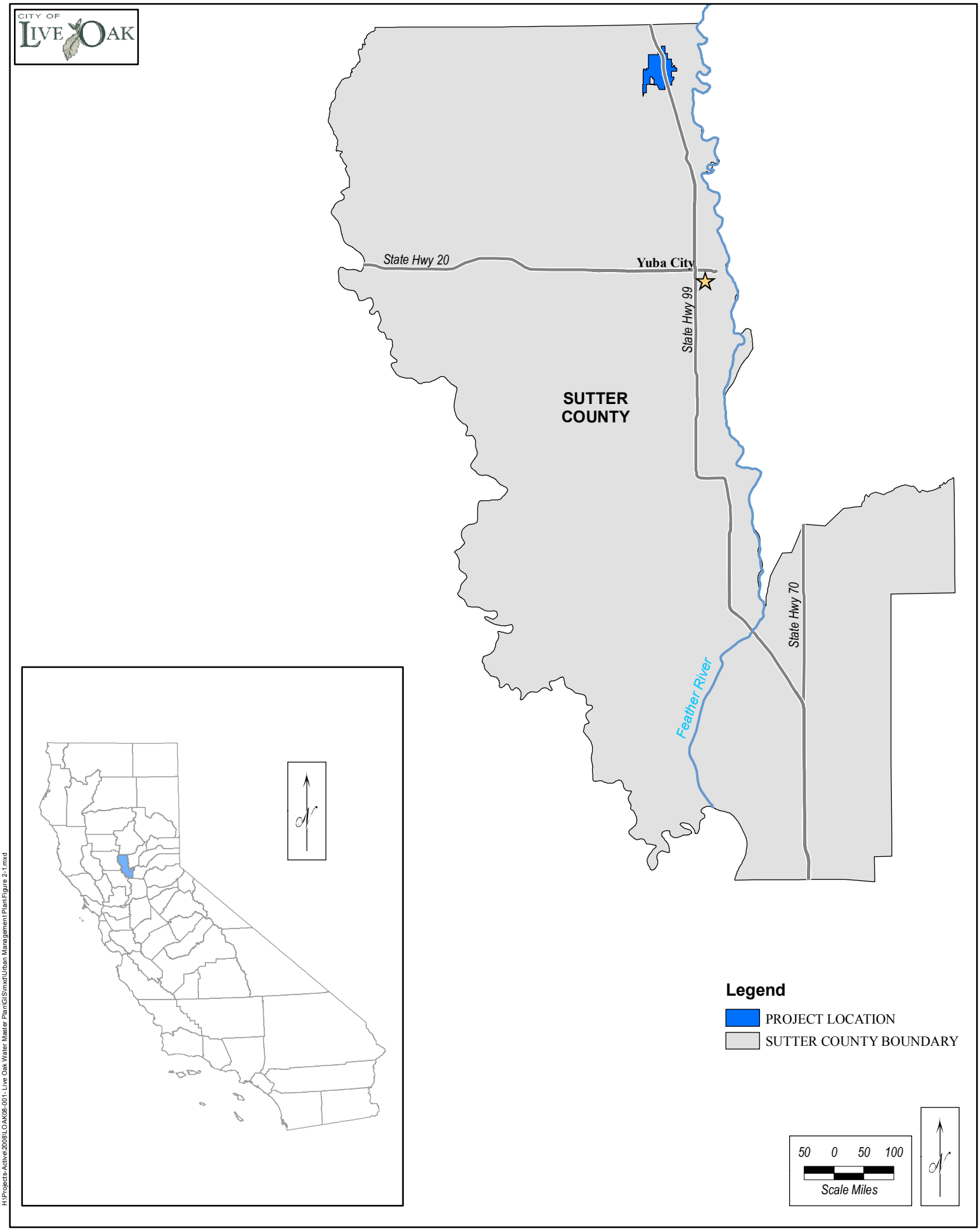
	2008	2010	2015	2020	2025	2030
City Population [(a)]	8,539	9,380	11,860	14,990	18,950	23,960

(a) Population estimates using a 4.8% growth rate based on historical growth data from 2001 through 2008 from *State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2008, with 2000 Benchmark. Sacramento, California, May 2008.*

The developed areas within the City consist of single-family and multifamily residential units; commercial establishments; and industrial, private, and governmental institutions. The City has established a sphere of influence encompassing approximately 1.9 square miles as outlined in Figure 2-2.

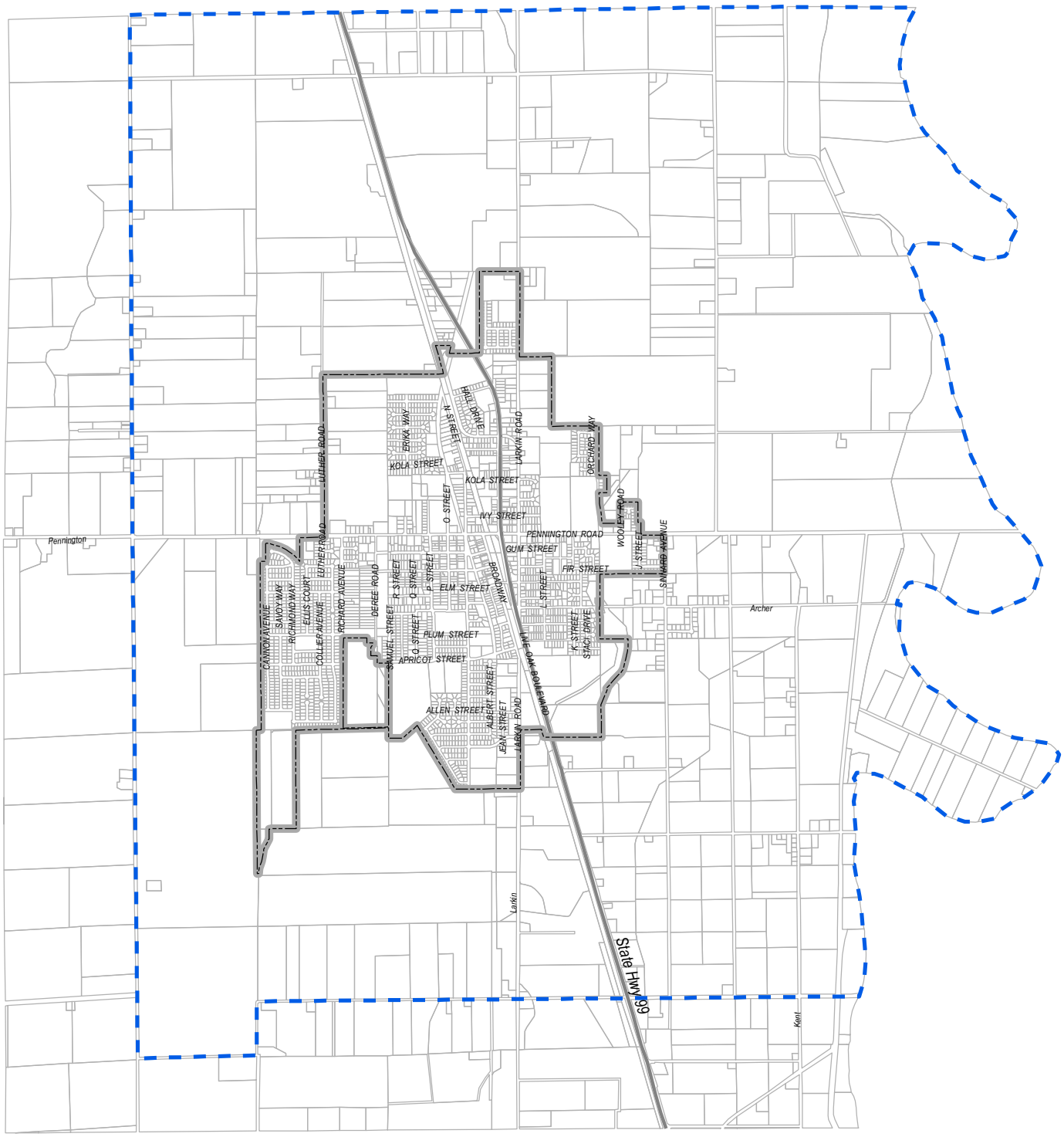
[1] State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2008, with 2000 Benchmark

[2] State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2008, with 2000 Benchmark



ECO:LOGIC ENGINEERING - **DRAFT**
CITY OF LIVE OAK - URBAN WATER MANAGEMENT PLAN

FIGURE: 2-1
VICINITY MAP



LEGEND

- SPHERE OF INFLUENCE
- CITY LIMITS

NOTES:

1. CITY LIMITS REPRESENT EXISTING SERVICE AREA.
2. SPHERE OF INFLUENCE REPRESENTS FUTURE SERVICE AREA.

1,500 0 1,500 3,000

Scale Feet

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ECO:LOGIC ENGINEERING - **DRAFT**

CITY OF LIVE OAK - URBAN WATER MANAGEMENT PLAN

FIGURE: 2-2

LIVE OAK CITY LIMITS AND SOI

2.4 PAST DROUGHT, WATER DEMAND, AND CONSERVATION INFORMATION

The local region experienced a drought from 1987 through 1991. The City was able to provide water to all customers without any water supply reductions or issues during that period. Historically a drought in this region will typically draw the static water levels down no more than 10 feet. The typical groundwater levels are 10 to 16 feet below ground level and with the wells pumping water from 100 feet or deeper, droughts have an insignificant impact on the City's water supply.

Water conservation is one of several priority policies for the City. The City will provide community education through utility bill inserts and newsletters, advertisements, in-classroom presentations, water awareness poster contests, and community events.

Section 3

Water Sources

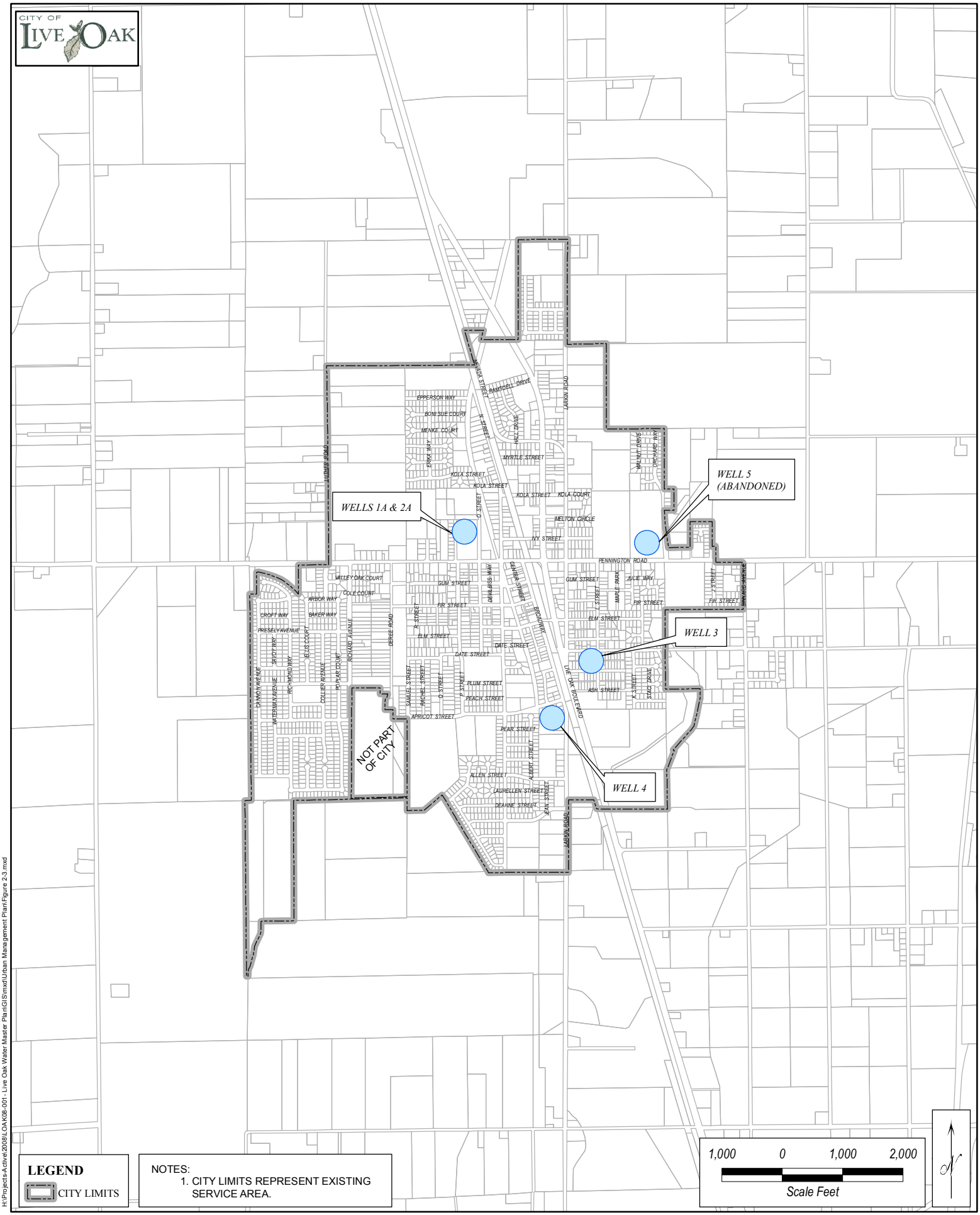
The sole source of water for the City of Live Oak is groundwater from the East Butte Subbasin of the Sacramento Valley Groundwater Basin. Water supply for domestic water service and fire flow is supplied from four wells owned and operated by the City. The wells are numbered 1A, 2A, 3 and 4. The current City of Live Oak water system service area, and well field is presented in Figure 3-1.

3.1 GROUNDWATER

3.1.1 REGIONAL GEOLOGY

A description of the Sacramento Valley Hydrologic Region (DWR Bulletin 118, 2004) indicates the groundwater levels have remained relatively constant, with levels usually within ten feet from the ground surface. According to the Geologic Map of the Sacramento Valley, (Water-Supply Paper 1497, Plate 2), the surficial geology of the Live Oak area consists of the Victor Formation and related deposits. These materials consist of "lenticular silt, sand, gravel and clay deposited by streams draining the Cascade Range." Bulletin 118, (Evaluation of Ground Water Resources: Sacramento Valley, 1978), states that the Victor Formation in the North Sacramento Valley was deposited by streams during the late Pleistocene and consists of silt, sand and buried channels of gravel. It directly overlies the Laguna Formation and is about 30 meters thick. The Victor is considered to be moderately permeable throughout and highly permeable where old stream channels are tapped. The yield of wells is generally low due to the limited saturated thickness.

The City of Live Oak lies within the southern portion of the East Butte Subbasin of the Sacramento Valley Groundwater Basin (California's Groundwater Bulletin 118, updated 2/27/04). The chapter describing the East Butte Subbasin does not include the Victor Formation as a water-bearing formation; although, it is including in the description of the subbasin to the south, known as the Sutter subbasin. Instead, it lists various Holocene stream and basin deposits, and Pleistocene units including the Modesto, Riverbank, Tuscan and Laguna Formations and the Sutter Butte Alluvium. These deposits consist of a variety of clays, silts, and gravels in varying proportions. The Pliocene Tuscan Formation is composed of a series of volcanic mudflows, tuff breccia, tuffaceous sandstone and volcanic ash layers in four units, two of which are found in the southern part of the subbasin.



LEGEND

CITY LIMITS

NOTES:
1. CITY LIMITS REPRESENT EXISTING SERVICE AREA.

H:\Projects-Active\2008\LOAK08-001 - Live Oak Water Master Plan\GIS\mxd\Urban Management Plan\Figure 2-3.mxd

ECO:LOGIC ENGINEERING - **DRAFT**
CITY OF LIVE OAK - URBAN WATER MANAGEMENT PLAN

FIGURE: 3-1
EXISTING WATER SERVICE AREA (CITY LIMITS)

The underlying Laguna Formation is composed of debris derived from the erosion of the Sierra Nevada and deposited as sand, silt, and gravel deposits that are moderately consolidated and poorly-to-well-cemented. The Laguna is non-volcanic and generally tan to brown. The thickness is approximately 500 feet. The formation is considered poorly to moderately permeable. Deep wells obtain moderate yields from sandy layers or from areas where soft, well-sorted granitic sand is present.

3.1.2 City of Live Oak Well Hydrogeology

The City currently has four wells to provide potable water, Wells 1A, 2A, 3 and 4. Well 5 has been removed from service due to high Nitrate and Arsenic levels. The wells are constructed dominantly in clay, with intervals of sand and gravel. No formation names were provided on the drill logs.

In Wells 1A and 2A, relatively thin sand intervals located between 160 and 210 feet below the ground surface (bgs) appear to be the most productive zones. This is based on camera surveys of the well bores performed prior to refurbishing in 2005. In Well 1A, cavities caused by sand washout of the original unlined well bore were observed at 161 ft bgs, 171-173 ft bgs, and 210 to 215 ft bgs. The large cavity at 210 to 213 is believed to be the zone that produces the most water. Although Well 1A was originally drilled to a depth of 386 ft bgs, when refurbished it had apparently collapsed or filled to a depth of 236 ft bgs; however, the current capacity is only slightly less than its original capacity. Adjacent Well 2A also appears to produce most water from a similar sand layer located between 210 to 225 ft bgs. Although it is screened to a greater depth, it does not currently produce significantly more water than Well 1A.

There is no log available for Well 3. Geologic information is limited to a description of an impervious layer beginning at 47 bgs. Well 4 produces entirely from a 30 ft screened interval of gravel at the bottom of the well located beneath a volcanic ash layer.

Based solely on the literature review and well log descriptions, the materials present in the Live Oak wells are likely to be Holocene Basin or Pleistocene Victor Formation deposits to a depth of about 100 feet, underlain by the Laguna Formation. The actual units and contacts cannot be determined based on the available drill logs. It is uncertain how the volcanic ash and cinders identified in Well 4 would fit in the overall stratigraphic sequence, but the materials may be volcanic sediments of the Tuscan Formation.

3.1.3 Pumping Test Data

Limited pumping data and groundwater information is available for the City of Live Oak wells. Geologic logs for Wells 2A and 3 indicate that static water levels are 11 to 16 ft bgs and that the groundwater is confined by near-surface clays. Pumping test data from the logs indicate that Well 2 was pumped at 1,000 gpm with 31 feet of drawdown, while Well 3 was pumped at 1,500 gpm with 26 feet of drawdown. These values indicate Specific Capacities of 32 and 58 gpm/ft, respectively, which are comparable to those published in the report: Evaluation of Ground Water

Resources: Sacramento Valley (1978, p. 65) which indicates that wells in the Live Oak area should have specific capacities in the range of 35 to 75 gpm/ft.

Adjacent Wells 1A and 2A can be used to estimate the maximum yield that might be attained from a well in this area. In Well 1A, a downhole camera survey was performed that indicated that most groundwater was produced from cavities or washouts at 161 ft, 175 to 177 ft, 187 ft, and 210 to 213 ft below the ground surface (bgs). Most water was said to come from the lowest cavity. At the above specific capacity, and with a static water level of 11 feet bgs, the well could potentially produce up to 4,800 gpm (150 ft x 32 gpm/ft) without drawing water levels below the uppermost sand layer. However, the well's 10-inch-diameter casing would prevent such production rates.

An empirical equation to approximate a confined aquifer's transmissivity (T) can be obtained from the above specific capacities, using the equation: T = 2000 x Specific Capacity (Driscoll, 1986). For Well 2, T would equal 64,000 gpd/ft (or 8,600 ft^2/day) while for Well 3, T would equal 116,000 gpd/ft (or 15,500 ft^2/day). A specific capacity of 75 gpd/ft would result in a T of 150,000 gpd/ft (or 20,000 ft^2/day). In the absence of formal aquifer stress test data, it is assumed the confined aquifer has a storage coefficient of $1x10^{-3}$.

3.1.4 East Butte Subbasin Summary

The Live Oak wells are located within the Sacramento Valley Groundwater Basin, East Butte Subbasin. According to California's Groundwater Bulletin 118, updated 2/27/04, the estimated specific yield for the East Butte Subbasin is 5.9 percent. The estimated storage capacity to a depth of 200 feet is approximately 3,128,959 acre-feet. Estimates of annual groundwater extraction for agricultural; municipal and industrial; and environmental wetland uses were 104,000, 75,500 and 1,300 acre-feet respectively, totaling 180,300 acre-feet. Deep percolation of applied water was estimated to be 126,000 acre-feet.

Assuming no recharge, the current City of Live Oak groundwater usage of 1,440 acre-feet annually (AFA) is about 1% of the total annual subbasin withdrawals, and less than $1/100^{th}$ of 1% of the total estimated storage capacity of the basin.

3.1.5 Existing Supply and Quality

In recent years, it had become evident that the City of Live Oak would need to treat water from some of its wells because of the diminishing availability of wells meeting drinking water quality requirements, notably arsenic. All wells were above the maximum contaminant level of 10 parts per billion (ppb) for arsenic. To address the problem, the City installed skid mounted treatment vessels with manganese oxide media for arsenic removal for the four wells currently in operation in 2008. All wells meet the arsenic standard.

Wells 1A and 2A have elevated nitrate levels. Each of these wells has violated the MCL once and will be continued to be monitored. Status, pumping capacity, depth to static water, and any known water quality concerns for all available groundwater wells are listed in Table 3-1.

Table 3-1
Groundwater Well Pumping Rate and Water Quality Concerns

Source	Status	Capacity (gpm)	Depth to Static Water (ft)	Depth to Pumping Water (ft)	Current Water Quality Concerns
1A	Active	650	11	51.5	Nitrate
2A	Active	700	11	47.0	Nitrate
3	Active [(a)]	750	11	37.0	-
4	Active [(a)]	935	11	Not Available	-
5	Abandoned	0	-	-	-
Booster PS	Active (assumes one pump off)	4,200	-	-	-
Total System Pumping Reliable Capacity (Wells 3, 4, and Booster PS) Wells 1A and 2A feed the tank.		5,885	-	-	-

(a) Based on information provided by the City in August 2009.

Peak pumping capacity of the City's active wells (Wells 1A, 2A, 3 and 4) is approximately 3,035 gpm. The existing reliable supply capacity and demand scenarios are listed in Table 3-2

Table 3-2
Existing Demand and Supply Comparison

Scenario	Reliable Supply	Average Day Demand[(c)]	Maximum Day Demand[(c)]	Maximum Day + Fire Flow Demand[(d)]	Peak Hour Demand [(e)]	Surplus/ (Deficit)
Existing Development-Annual Average (gpm)	2,100 [(a)]	1,310	-	-	-	790
Existing Development-Maximum Day (gpm)	2,100 [(a)]	-	3,320	-	-	-1,220
Existing Development-Maximum Day+ Fire (gpm)	5,885 [(b)]	-	-	7,320	-	-1,435
Existing Development-Peak Hour (MG)	1.4 [(b)]	-	-	-	1.2	0.2

(a) Includes Wells 1A, 2A, and 3. Well 4 is not included, because it is the largest source per Title 22, Chapter 15, Section 64554, R-13-03. The booster pump station is not included because average day and maximum day supply must come from the wells.

(b) Includes Wells 3 and 4 and booster pump station. The largest source out of service is the standby pump at the booster pump station.

(c) Demand includes committed unbuilt demands and is therefore higher than actual demand.

(d) Based on a fire flow of 4,000 gpm as discussed in Chapter 4.

(e) Per Title 22, Chapter 15, Section 64552, R-13-03, peak hour needs be met for four hours.

For existing conditions, the City does not have reliable supply capacity for maximum day.

Average water production from 2005 through 2008 indicate an overall decrease in water use from all City water customers (Table 3-3). The water production dropped in 2006 when water meters were beginning to be installed. This pattern is typical when users realize they are now billed for any extra water they use or waste when they are connected to a meter.

Table 3-3
Groundwater Production (AFA)

City Produced Groundwater	2005	2006	2007	2008
East Butte Subbasin (a)	1,640	1,500	1,410	1,440
% of Total Water Supply	100	100	100	100

(a) Based on water production records provided by be City.

According to California's Groundwater Bulletin 118, updated 2/27/04, groundwater level fluctuations for composite wells within the southern portion of Butte County averaged about 4 feet during normal years and up to 10 feet during drought years.

No water level data is available for the City of Live Oak municipal wells. However, hydrographs for nine wells in the area surrounding Live Oak were obtained that have water level data extending back as far as 1947 and up to 2005. The monitoring well groundwater elevations indicate a groundwater flow direction to the south, at a gradient of about 2.4 feet per mile.

Similar to Bulletin 118, these data show that groundwater fluctuations are typically no more than 10 feet. Six of the wells do not show any long-term decline in groundwater elevations. In the other wells, long-term declines appear to be less than five feet. In the drought period of 1987 to 1992, additional declines in individual years of two to four feet are visible only in some wells, but water level recoveries in winter months were generally not as pronounced as in wetter years. Hydrographs for the three closest wells to the Live Oak municipal wells, 16N03E07D002M, 17N03E30N001M and 17N03E33P001M, show no long term water level declines, but do show decreased recharge during the drought period, see Figure 3-2. However, these decreases are generally on the order of six feet or less. Trend lines for two of the three wells actually indicate rising water levels over the 60 year period. Based on these data, there are no reliability issues with the subbasin at current pumping rates.

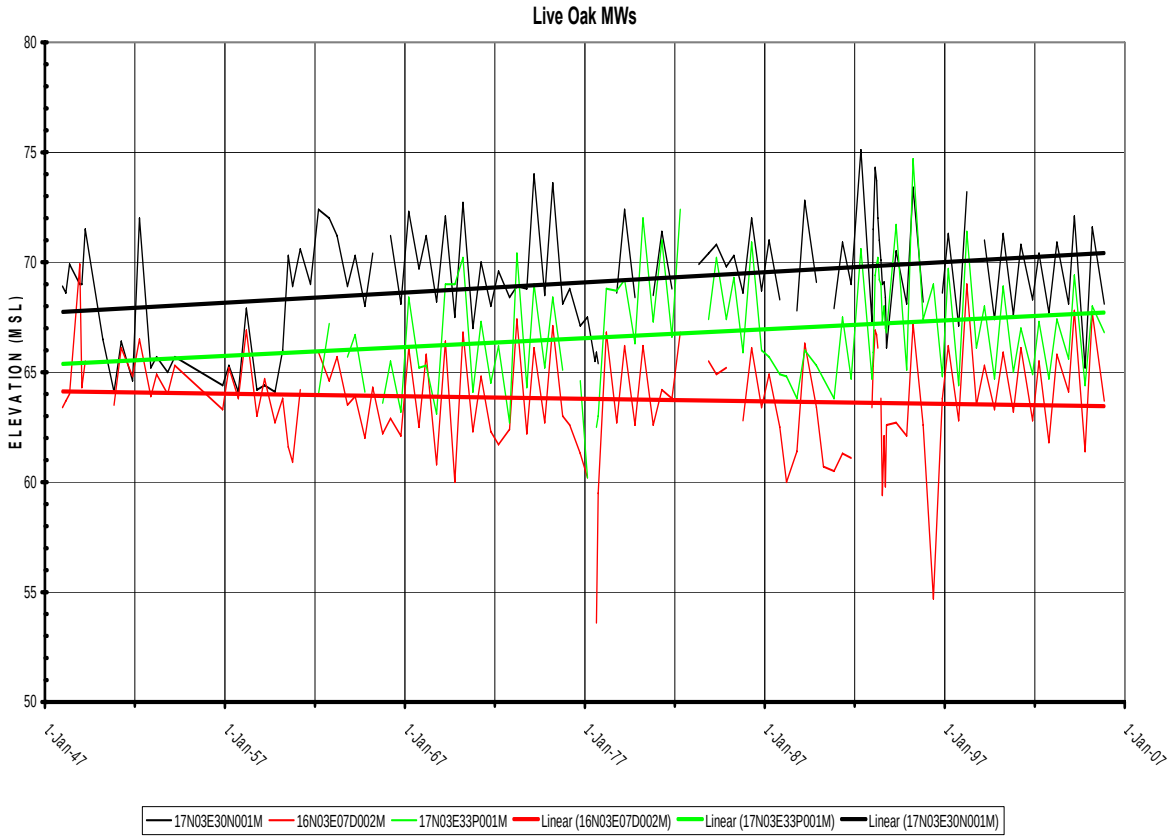


Figure 3-2
Groundwater Levels of Area Monitoring Wells Showing Long-term Trends

Long term pumping at existing rates has not significantly impacted the aquifer in the area of the City of Live Oak. Even during extended drought years, such at 1987 to 1991, temporary water level drops were limited to less than 10 feet.

The aquifer appears to have the capacity to supply additional production. Not including recharge from irrigation, only a small percentage of the storage capacity in the upper 200 feet of the aquifer is tapped. It appears that properly spaced wells will be able to provide the required capacity, although water quality issues may be an issue in some areas.

3.1.6 FUTURE GROUNDWATER SUPPLY

Future groundwater will come from new wells. Planning level assumptions regarding future wells are as follow:

- New wells will produce a minimum of 2,000 gallons per minute (gpm). Based on the well logs of the existing wells, the current production may be limited by the screened length and well casing size. Future wells may be able to produce more water by increasing the well casing size.

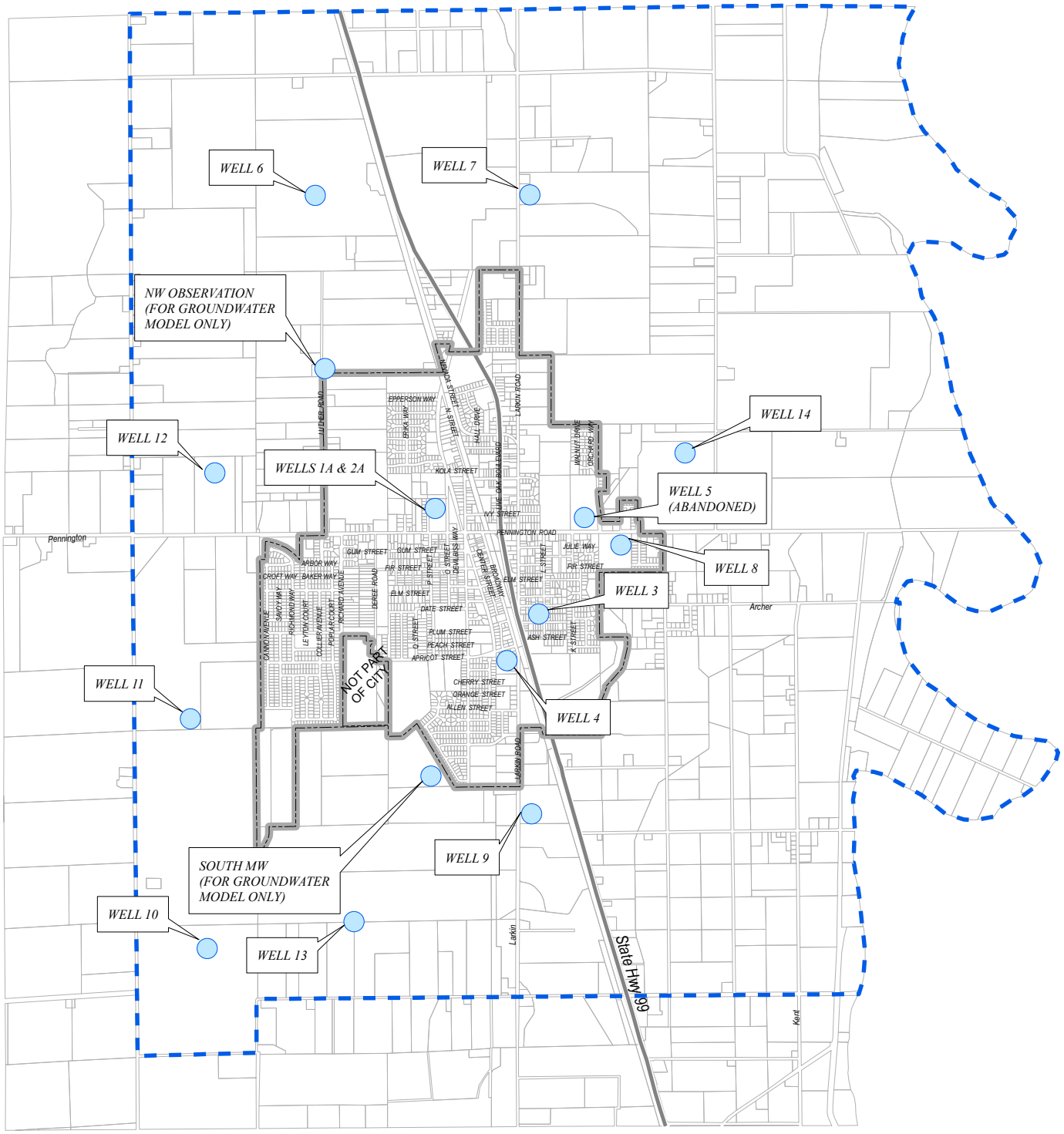
- Water quality will be similar to the existing wells and would require the same treatment as the existing wells. During well design the City should attempt to maximize water quality to avoid treatment, which could include deeper wells and/or screening selected intervals with the highest quality water.
- The underlying groundwater aquifer will provide adequate long-term water supply.
- The reliable system capacity will be sized so that MDD can be met with the largest well out of service.

The estimates of aquifer parameters discussed in Section 3.1 .3, combined with estimates of future groundwater usage, were then used to predict potential aquifer drawdown under buildout conditions during average, and single, and multiple dry year conditions. As shown in Table 3-4 and Figure 3-3, it is anticipated that the average buildout demand of 7,300 gpm would be met by thirteen wells completed in Live Oak and around its perimeter. The average monthly pumping rates for each well would be variable, but would be greatest (up to 900 gpm) during the high demand months of July and August.

Table 3-4
Estimated Buildout Demands and Well Pumping Rates

Month	Buildout Demand (MG)	Buildout Demand (gpm) (a)	Buildout Average gpm per well (13 wells) (a)
January	180	4,000	310
February	160	4,000	310
March	240	5,400	410
April	340	7,900	610
May	400	9,000	690
June	470	10,900	840
July	500	11,200	860
August	490	11,000	840
September	390	9,000	690
October	280	6,300	480
November	210	4,900	370
December	180	4,000	310
Total or average	3,840	7,300	560

(a) Assuming the wells are pumping 24 hours a day.



LEGEND

- SPHERE OF INFLUENCE
- CITY LIMITS

NOTES:
1. CITY LIMITS REPRESENT EXISTING SERVICE AREA.

1,500 0 1,500 3,000
Scale Feet

H:\Projects-Active\2008\LOAK08-001- Live Oak Water Master Plan\GIS\mxd\Urban Management Plan\Figure 3-3.mxd

ECO:LOGIC ENGINEERING - **DRAFT**
CITY OF LIVE OAK - URBAN WATER MANAGEMENT PLAN

FIGURE: 3-3
EXISTING AND FUTURE WELL LOCATIONS

The performance of the hypothetical wells and their effect on the aquifer was simulated using the computer program AQTESOLV (HydroSOLVE, 2007; computer program AQTESOLV Pro for Windows, ver 4.50.13) which incorporates the confined aquifer groundwater model of Dougherty-Babu (1984). The locations of the thirteen wells and the average monthly pumping rates were incorporated into the simulation. As shown in Figure 3-4, if only one well were pumping, using average monthly pumping rates, a transmissivity of 12,000 ft^2/day and a storage coefficient of 0.001, the anticipated drawdown in the well at the end of three years of pumping would be about 26 feet. This is similar to, or slightly more than, the values determined from brief pumping tests described above, and indicates that the assumed aquifer parameters are reasonable. The model used in AQTESOLV assumes that there is no recharge to the aquifer and therefore, the simulations are considered to represent drought conditions (single or multiple year depending on simulation). Although unlikely, this provides a conservative estimate useful for drought planning, because after multiple years of lower-than-normal precipitation, all the water pumped is derived from storage in the aquifer. As a result, it provides a likely upper limit to water level declines in an extreme drought situation. It does not account for other drawdown impacts that could result from other regional groundwater pumping.

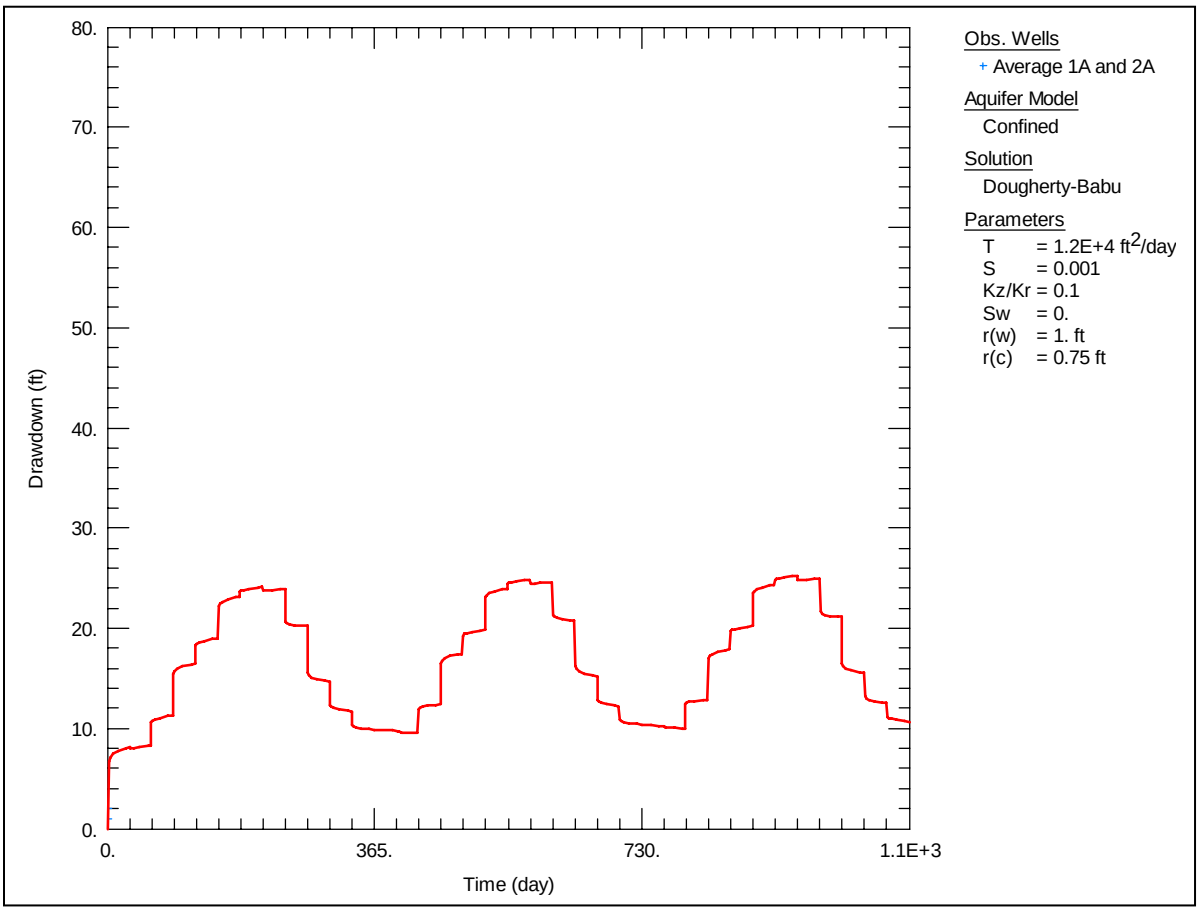


Figure 3-4
Predicted drawdown using the average aquifer parameters

When multiple wells are present in an area, there will be interference between them that will increase the total amount of drawdown. When all thirteen wells are incorporated into the simulation, each pumping at the average buildout rates shown in Table 3-4, the predicted drawdown would increase to that shown in Figure 3-5. In this case, the total estimated drawdown at centrally-located well 1A (at the end of three years of pumping and in the absence of recharge) would be greatest – on the order of 110 feet. The estimated drawdown at one well on the northern perimeter of Live Oak (Well 7), one well on the southern perimeter (Well 13), one well on the eastern flank (Well 8), and two non-pumping monitoring points, one about 3,750 feet northwest of Well 1A, and one about 5,250 feet to the south is also shown. Drawdown at each of the monitoring wells would be approximately 80 feet. Please note that the calculated interference drawdown is a relatively crude estimate because the aquifer is known to be heterogeneous, while the analytical simulation assumes uniform conditions in the aquifer.

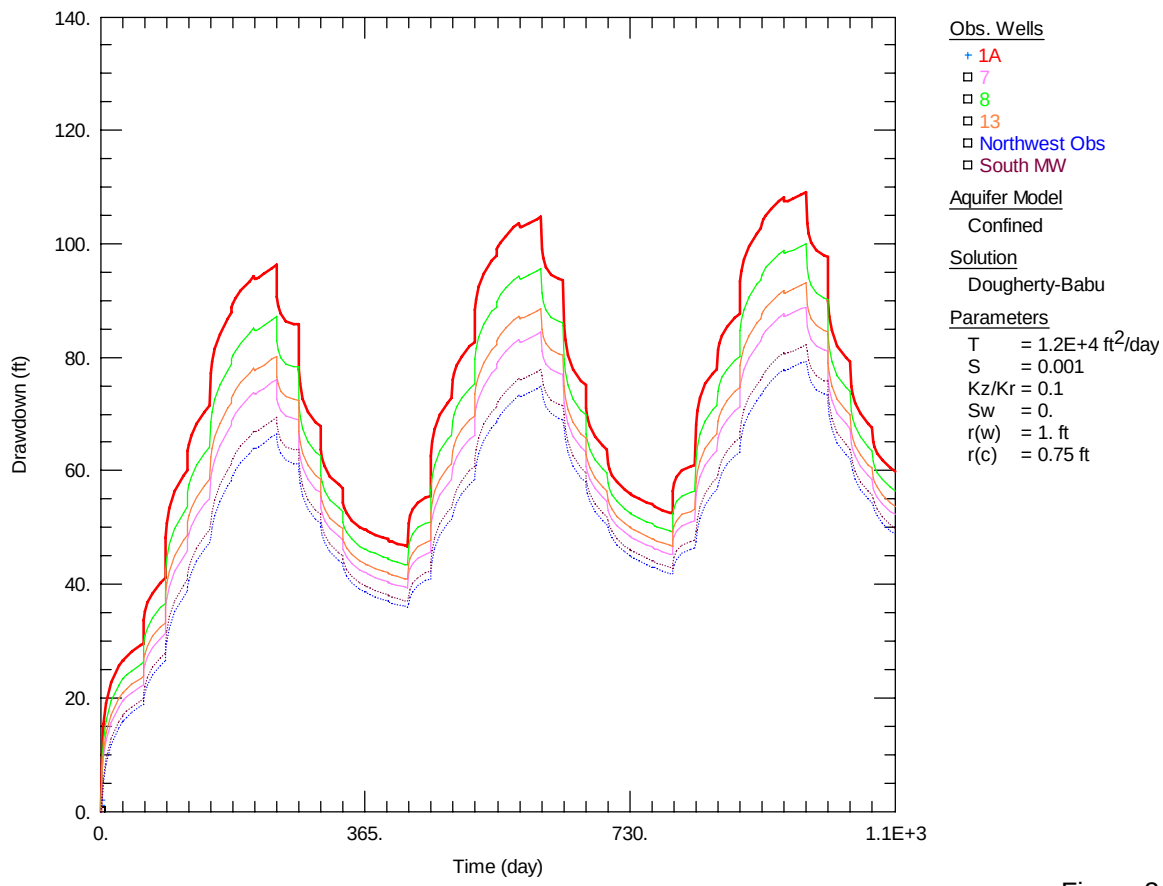


Figure 3-5
Predicted drawdown from thirteen wells pumping an annual average of 7,300 gpm, using the average estimated Transmissivity value

Any changes in the aquifer parameters would result in different drawdown rates. For instance, if the transmissivity is 16,000 ft^2/day instead of 12,000 ft^2/day, the drawdown would be more than 20% less, as shown in Figure 3-6. Alternatively, if the transmissivity is 12,000 ft^2/day, but the storage coefficient is 0.0001 instead of 0.001, drawdown in the central well 1A at the end of three years could be as much as 140 feet (again in the absence of aquifer recharge) as shown in Figure 3-7. Without performing pumping tests on the wells, their long-term performance is somewhat speculative at this time, but is likely to be within this range of values.

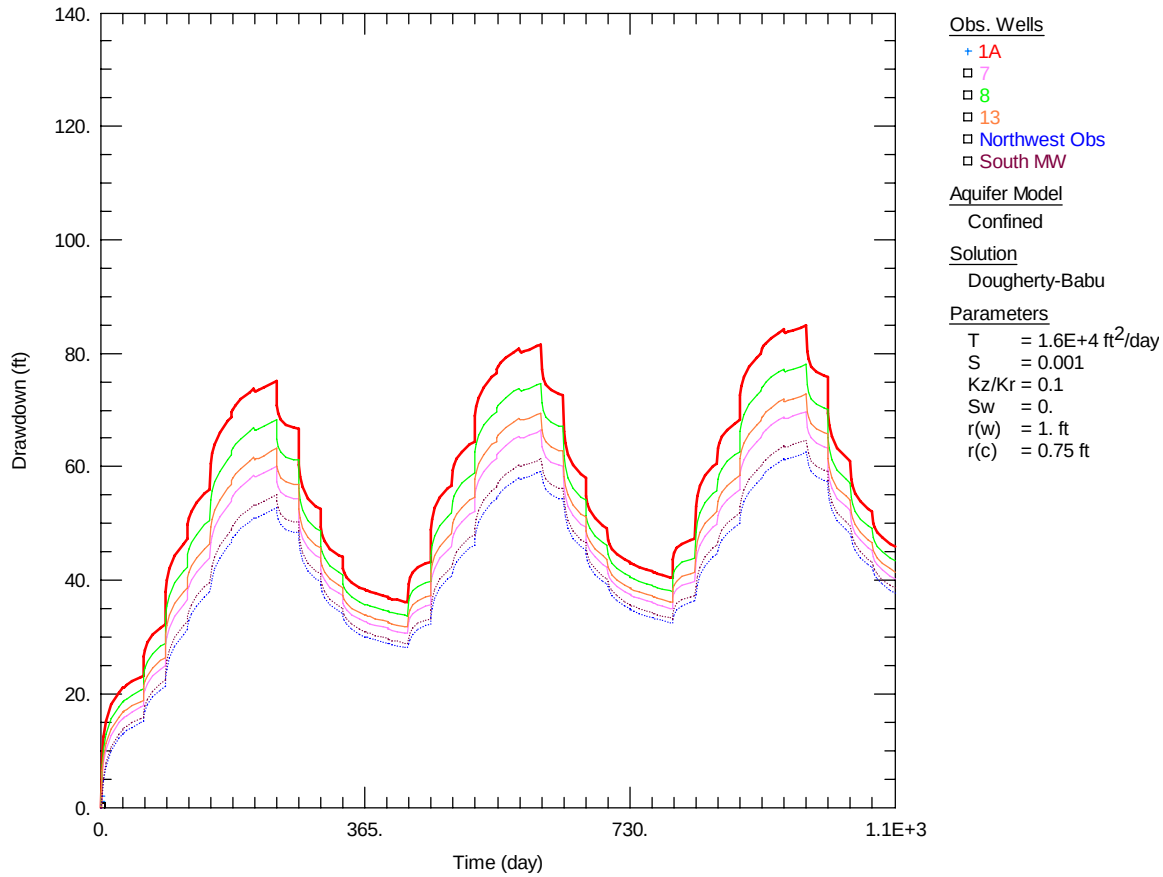


Figure 3-6
Predicted drawdown from thirteen wells pumping an annual average of 7,300 gpm, using a higher estimated Transmissivity

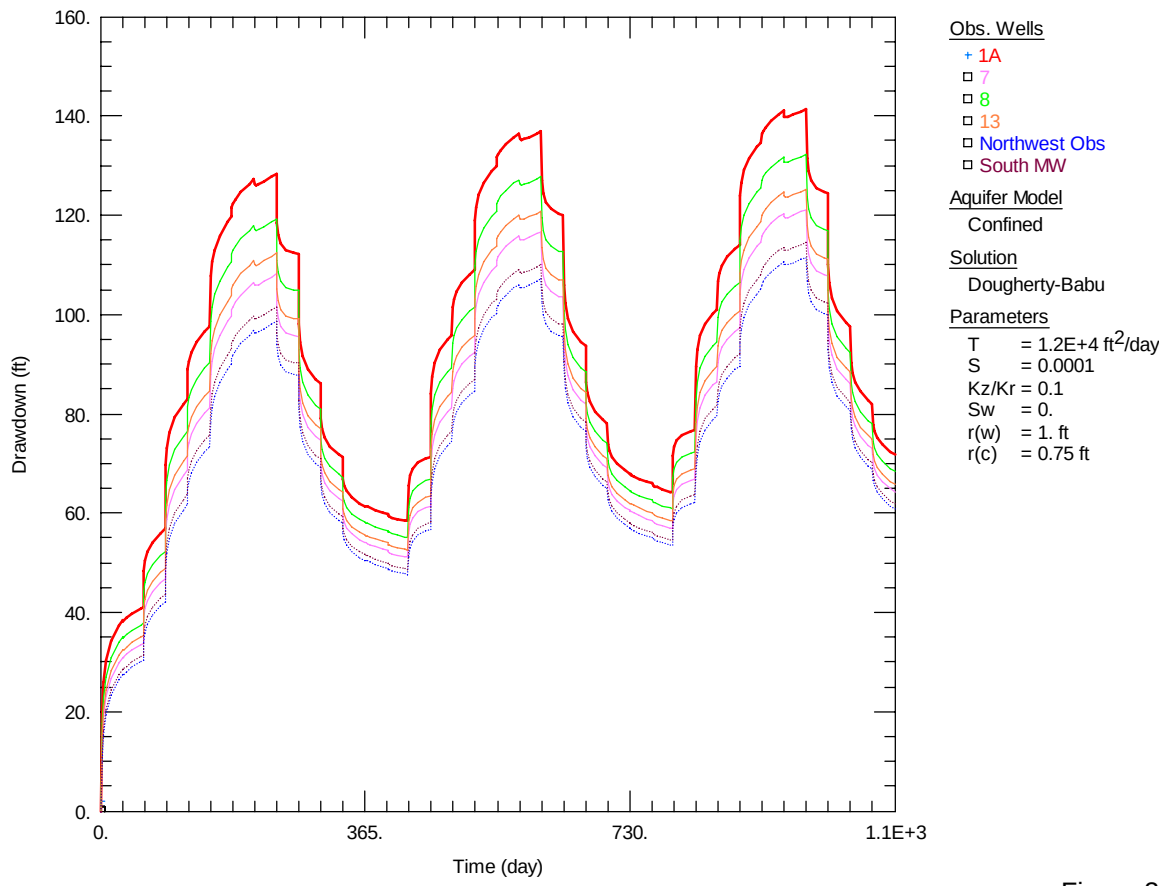


Figure 3-7
Predicted drawdown from thirteen wells pumping an annual average of 7,300 gpm, using the average estimated Transmissivity but a smaller storage coefficient

Effect of Multiple Dry Years on Well Performance

For Live Oak wells, the "static" water level is typically about 10 feet below the ground surface. Well construction logs for the existing four wells indicate that the top of the screen interval begins anywhere from 100 to 390 feet below the ground surface. Because it is desirable to not draw water levels below the top of the screened interval, it is possible under the above pumping scenarios that drawdown could exceed this typical operating standard in some wells (particularly if other area pumping results in a significant seasonal decrease in the "static" water level). However, as previously described, most water from the existing Live Oak wells is apparently produced from relatively thin sand layers that exist at depths of 160 feet or more below the surface. If so, even the large drawdown shown in Figure 3-7 would likely not result in exposure of the screen to the atmosphere. Even if this were to occur, it would not prevent the well field from producing the required volume of water. New wells could be constructed with these predicted drought-year drawdown values in mind.

Under the estimated potential worst case condition of a multiyear drought, and no aquifer recharge, the additional drawdown may require pump modifications for the existing wells. The

modifications may include lowering the pump, or replacing the pump if the new design point is not within the current pump capabilities.

Projected Water Supplies

Projections for future groundwater supply are presented in Table 3-5. The additional production is based on adding additional wells as required to meet demand. The future water supply in 2030 is sufficient to meet the projected 2030 maximum day water demand. The 2030 water demand is based on the General Plan land use. Future water capacity will be provided from new wells throughout the system. Future wells are expected to provide at least 2,000 gpm for maximum day, and 770 gpm for an average day.

Table 3-5
Current and Projected Water Supplies (AFA)

Water Supply Sources	2009 (a)	2010	2015	2020	2025	2030
Existing Groundwater	3,120	3,120	5,590	8,070	8,070	9,310
New Groundwater (b)	0	2,470	2,480	0	1,240	3,720
Surface Water	0	0	0	0	0	0
Recycled Water	0	0	0	0	0	0
Total	3,120	5,590	8,070	8,070	9,310	13,030

(a) Based on average existing well supply capacity in 2008.
(b) Based on adding additional wells as required. Average well flow is shown.

3.2 LOCAL SURFACE WATER

The City currently does not treat any surface water and does not have any plans to obtain surface water in the future. The underlying groundwater basin appears to be adequate to provide a reliable water source and therefore surface water will not be pursued.

3.3 TRANSFER AND EXCHANGE OPPORTUNITIES

Transfer and exchange of water would be difficult for the City of Live Oak as there are no nearby municipalities or irrigation districts. Connecting to the next closest municipal system in Yuba City would require approximately 12 miles of pipeline.

3.4 RECYCLED WATER

The existing Live Oak Wastewater Treatment Facility consists of fine screening, aerated treatment ponds and lagoons, and chlorine disinfection with subsequent de-chlorination. Treated effluent is discharged to Reclamation District 777 Lateral Drain Number 1. The average annual flow for the treatment facility is 0.8 mgd (2008). Currently no wastewater is produced for recycled water use.

The City was issued a new waste discharge permit and a new cease and desist order (CDO) in July 2004, which reflected new regulatory requirements and gave the City a five-year timeline to bring its treatment facilities into compliance. New regulatory requirements mandate a significant upgrade in the level of treatment and/or development of a new method or location of treated effluent disposal.

The City has elected to complete the necessary upgrades to meet the new permit limits. The upgraded plant will be constructed to meet Title 22 quality effluent that could potentially offset some potable water use for landscape irrigation or groundwater use for local crop irrigation. Since the City is not currently planning or pursuing production of recycled water, this UWMP assumes no future use of recycled water.

3.5 DEVELOPMENT OF DESALINATED WATER

In preparing this UWMP, the opportunities for development of three desalinated water sources were reviewed, 1) ocean water desalination, 2) brackish ocean water desalination, and 3) brackish groundwater desalination. The results of this review are as follows:

1. The City of Live Oak is located inland within the central Sacramento Valley. Ocean water is not readily available and therefore no opportunities currently exist for desalination of ocean water.

2. Live Oak is situated northeast of the Sacramento Delta, a distance of more than eighty miles. As with ocean water, brackish ocean water that may exist in the delta area is not near Live Oak and therefore no opportunities currently exist for the desalination of brackish ocean water.

3. It is possible that shallow groundwater impacted by historic agricultural practices or deep groundwater originating from marine sediments may represent sources of brackish groundwater in the vicinity of Live Oak. Although the cost of membrane processes for the desalination of brackish water has been decreasing, several obstacles continue to exist for the City to consider these sources as potentially viable long-term water supplies:

   – Shallow brackish water supplies, if they exist, have few barriers for protection from surface contamination and therefore would make poor potable water sources.

   – Deep brackish groundwater requires deep pumping and special attention to well design to avoid possible cross contamination with higher quality sources.

   – Membrane treatment capital and operation and maintenance costs for salinity removal currently far exceed the costs for other conventional treatment mechanisms and therefore would be considered only if other water sources were not available.

- Desalination treatment produces a high total dissolved solids waste stream that is very costly for disposal. Disposal would likely entail one or more of the following:
  - Brine drying via heat evaporators for disposal in a permitted landfill;
  - Brine drying using solar drying (in ponds designed to meet the containment requirements of designated waste) for disposal in a permitted landfill, or;
  - Ocean disposal in liquid form through trucking to a sea outfall.

Section 4

Reliability Planning

A reliable water source is crucial for any region or City. Reliability is a measure of a water service system's expected success in supplying short term and long term water needs under extreme conditions. To plan for long term water supply reliability, the water supplier needs to investigate increasing water supply and demand reduction options to determine the best course of action for meeting water service needs. In addition to climate, other factors that can cause water supply shortages are earthquakes, chemical spills, and energy outages at pumping and storage facilities. Changes in aquifer water quality also impact the availability of groundwater supplies, and these impacts have affected several of the City's wells in the past, such as Arsenic.

4.1 FREQUENCY AND MAGNITUDE OF SUPPLY DEFICIENCIES

California experienced a severe drought during 1976/77. Another significant drought was experienced in the late 1980's and early 1990's. The City had sufficient water supplies during these drought periods without any major issues or shortfalls, as discussed in Section 3.1.5.

4.2 PLANS TO ASSURE A RELIABLE WATER SUPPLY

Water use efficiency improvements and development of new water supplies will be necessary to meet the City's projected water demand. The City will continue to examine supply enhancement options, including additional wells. Recycled water is also a reliable water source because it is consistently available; therefore, the City will continue to study recycled water use options where groundwater degradation is not a result.

4.3 RELIABILITY COMPARISON

The region experienced drought conditions during the period of 1977 and 1987 to 1991. As was previously stated, the water supply was not affected by the drought. During the drought periods the static ground water levels decrease minimally which had no affect the pumping capacity of the wells.

For planning purposes, reliability of water supply is examined by comparing water supply in a normal year to the supply that would be available during a drought period. Table 4-1 compares the water supplied to the City during a normal water year (2008) to the projected water supply associated with a single dry year (1977) and multiple dry years (1987-1991). Historically a drought in this region will typically draw the static water levels down no more than 10 feet. The typical ground water levels are 10 to 16 feet below ground level and with the wells pumping

water from 100 feet or deeper, droughts have an insignificant impact on the City's water supply. Therefore, the water supply was not decreased for drought years.

Table 4-1
Estimated Reliable Water Supply Reduction During Drought Scenarios

		Multiple Dry Water Years		
Normal Water Year (2008) (AFA) (a)	**Single Dry Water Year (AFA)**	**Year 1 (AFA)**	**Year 2 (AFA)**	**Year 3 (AFA)**
1,880	1,880	1,880	1,880	1,880

(a) Based on average supply from City's Wells 1A, 2A, 3 and 4.

4.4 THREE YEAR MINIMUM WATER SUPPLY

The minimum water supply for three years is listed in Table 4-2.

Table 4-2
Estimated Minimum Reliable Water Supply

	2009	2010	2011	2012
Minimum Water Supply (gpm)	5,885	11,885	11,885	11,885

(a) Assumes 3 new 2,000 gal per minute well is installed in 2010.

Section 5

Water Use

5.1 WATER USE BY SECTOR

When the City retrofitted all its customers with water meters, the City developed a system to account for customer types and consumption. Meter categories include church, city property, commercial, duplex, fire station, government, library, multi-family dwelling, post office, school, single-family dwelling, and trailer park. Accordingly, each would have different needs and different rationing allocations if rationing became necessary.

The General Plan buildout land use was used to project customers and water use to the year 2030. Each water use sector was assumed to grow linearly from 2008 until 2030. Residential customers were assumed at one meter per dwelling unit. Nonresidential customers were assumed at one meter per equivalent dwelling unit (EDU). An EDU was defined as 500 gpd based on a single-family residence demand. The projected increase in water customers is presented in Table 5-1, and the projected increase in water use is presented in Table 5-2.

Table 5-1
Projected Increase of Water Customers Served by Live Oak (customers/Year) [a, b]

Water Use Sectors	2008	2010	2015	2020	2025	2030
Single Family Residential						
Metered	1,995	3,290	6,520	9,760	12,990	16,230
Unmetered	0	0	0	0	0	0
Multi Family Residential						
Metered	60	110	220	340	450	570
Unmetered	0	0	0	0	0	0
Commercial						
Metered	74	170	400	640	870	1,110
Unmetered	0	0	0	0	0	0
Industrial						
Metered	1	1	1	1	1	1
Unmetered	0	0	0	0	0	0
Institutional/Government						
Metered	10	110	350	600	840	1090
Unmetered	0	0	0	0	0	0
Landscape						
Metered	19	100	300	490	690	890
Unmetered	0	0	0	0	0	0
Agricultural						
Metered	0	0	0	0	0	0
Unmetered	0	0	0	0	0	0
Lower Income Households						
Metered	0	30	90	160	220	290
Unmetered	0	0	0	0	0	0
Total	**2,200**	**3,800**	**7,900**	**12,000**	**16,100**	**20,300**

(a) Based on General Plan buildout land use.

(b) Assumes half of the general plan buildout high density residential is lower income households and the other half is multifamily.

Table 5-2
Projected Water Use by Water Use Sector (AFA) [a, b]

Water Use Sectors	2008	2010	2015	2020	2025	2030
Single Family Residential						
Metered	1,330	2,040	3,800	5,560	7,330	9,090
Unmetered	0	0	0	0	0	0
Multi Family Residential						
Metered	160	170	210	250	280	320
Unmetered	0	0	0	0	0	0
Commercial						
Metered	30	80	220	350	490	620
Unmetered	0	0	0	0	0	0
Industrial						
Metered	50	50	50	50	50	50
Unmetered	0	0	0	0	0	0
Institutional/Government						
Metered	420	440	480	520	570	610
Unmetered	0	0	0	0	0	0
Landscape						
Metered	20	60	170	280	390	500
Unmetered	0	0	0	0	0	0
Agricultural						
Metered	0	0	0	0	0	0
Unmetered	0	0	0	0	0	0
Lower Income Households						
Metered	0	10	50	90	120	160
Unmetered	0	0	0	0	0	0
Unaccounted for Water						
Metered	0	0	0	0	0	0
Unmetered	80	114	199	284	369	450
Total	**2,100**	**3,000**	**5,200**	**7,400**	**9,600**	**11,800**

(a) Based on General Plan buildout land use.

(b) Assumes half of the general plan buildout high density residential is lower income households and the other half is multifamily.

5.1.1 Residential Sector

Live Oak averaged 3.4 persons per housing unit for residential customers in the 2000 U.S. census. The City mainly consists of single-family residences; however there are also duplexes and multi-family complexes. The City also has three mobile home parks.

5.1.2 Commercial Sector

The City has a mix of commercial customers including grocery stores, business offices, gas stations, medical complexes, and restaurants.

5.1.3 Industrial Sector

Sunsweet is an industrial user of water currently. Per buildout land use, there are no additional industrial uses of the water in the future.

5.1.4 Institutional / Government Sector

The City has many institutional and government customers such as churches, fire department, library, parks, post office, and schools.

5.1.5 Landscape and Agricultural Irrigation Sector

Landscape irrigation is currently provided for parks. The City does not provide water for agricultural irrigation. The agricultural areas outside the City provide their own water supply through irrigation canals and their own wells.

5.1.6 Wholesale to Other Agencies

The City of Live Oak does not currently provide any wholesale water to any other agencies.

5.1.7 Other Water Uses

Other water uses include unaccounted water. Unaccounted water is considered water that is produced and distributed but is not sold or metered. Sources of unaccounted water include water system leaks, inaccurate meters, theft, fire protection, and unmetered water used for flushing dead ends within the system to maintain water quality.

Section 6

Water Demand Management Measures

6.1 INTRODUCTION

The City of Live Oak is committed to the implementation of the most feasible water conservation measures appropriate for the City to produce the greatest reduction in water use. The City of Live Oak is not signatory to the Memorandum of Understanding regarding Urban Water Conservation in California (MOU) and is therefore not a member of the California Urban Water Conservation Council (CUWCC).

Recent amendments to the California Water Code as described in Assembly Bill 1420 (Laird), set eligibility of loans and grants made available by the State Water Control Board or California Bay-Delta Authority conditioned on the implementation of Demand Management Measures (DMM)'s described in the UWMP. The DMM's described below will use the same framework as the Best Management Practices (BMP)'s listed in the MOU due to the amount of research conducted by CUWCC in determining reliable conservation estimates. However, for the DMM's described herein are distinctly different from the MOU BMPs in such that the implementation, scheduling, and reporting period have been based on City specific level of effort and compliance with the UWMPA. A summary of the demand management measures is presented in Table 6-1.

Table 6-1
Summary of Demand Management Measures

DMM	Description	Live Oak Compliance with UWMPA
1	Water Survey Programs for Single-Family Residential and Multi-Family Residential Customers	(a)
2	Residential Plumbing Retrofit	(a)
3	System Water Audits, Leak Detection, and Repair	Implemented
4	Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections	Implemented
5	Large Landscape Conservation Programs and Incentives	(a)
6	High Efficiency Washing Machine Rebate Program	(a)
7	Public Information Programs	(a)
8	School Education Programs	(a)
9	Conservation Programs for Commercial, Industrial, and Institutional Accounts	(a)
10	Wholesale Agency Programs	N/A
11	Conservation Pricing	(a)
12	Water Conservation Coordinator	(a)
13	Water Waste Prohibition	(a)
14	High Efficient Toilet Replacement	(a)

(a) To be implemented by the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

6.2 DEMAND MANAGEMENT MEASURES (DMM)

The City is committed to providing safe and reliable water to City customers in the most efficient and cost effective manner therefore, in response to the UWMPA, the City will address the 14 DMM's.

For each DMM, an overall outline of the City's schedule for DMM implementation is provided with a means of tracking and evaluating DMM implementation and effectiveness. Specifics tasks will be summarized and reported in UWMP updates for each DMM therefore, a reporting period is defined as the five year period between UWMP updates.

6.2.1 DMM 1 – WATER SURVEY PROGRAMS FOR SINGLE-FAMILY RESIDENTIAL AND MULTI-FAMILY RESIDENTIAL CUSTOMERS

Most residential customers unknowingly use water inefficiently and take for granted this limited resource. Additionally, customers don't understand the amount of water wasted by over watering their landscape. A water survey program will educate City customers on efficient landscape water use, test fixtures for leaks, provide information on other services available to them (other DMM's) such as rebates and free water efficient fixtures.

DMM Description

The Water Survey Program for Single-Family Residential and Multi-Family Residential Customers consists of the following actions:

- Define the funding source and allocate appropriate funds for this DMM.
- Assign Water Conservation staff.
- Target high use customers and market water use surveys to single-family residential and multi-family residential customers through the following actions.
  - On an annual basis (each August), compile single-family and multi-family residential user account information and water use data. This information will be analyzed to prioritize the marketing efforts described below. High volume water use customers as identified as being the top five percent (5%) highest water consumers will be the focus for initial marketing efforts followed by the remaining 15 percent (15%) as determined by water use ranking priority to make up the target 20 percent (20%) marketing effort as outlined in this measure.
- Develop or identify marketing material to be used for initial contact, during surveys and follow-up to surveys.
  - Compile DMM specific materials/equipment such as educational materials, tools for minor irrigation system repair, flow and measurement equipment, replacement sprinkler equipment and other applicable materials and equipment.
- Directly contact via letter or telephone not less than 1% of single-family residential customers and 1% of multi-family residential customers each year with an offer to conduct a water survey.
  - Priority in contact shall be given to those high volume use customers identified above.
  - Telephone followed by letter contact shall be conducted for users identified above as high volume use customers.
  - Letter correspondence and telephone contact shall include information on other DMM services available to the customer such as high efficient toilets, high efficient washing machines, and free water conserving retrofit devices.
- Conduct surveys of all positive respondents to survey offer and other interested customers becoming aware of the survey through DMM 7. Surveys shall include indoor and outdoor components, and at minimum shall have the following elements:

  Indoor

  - Check for leaks, including toilets, faucets, and water meter;
  - Check showerhead flow rates, aerator flow rates, and offer to replace (see DMM 2) or recommend replacement, as necessary;

- Check toilet flushing rating and recommend installation of displacement device or direct customer to HET rebate program, as necessary; replace leaking toilet flapper, as necessary;
- Check and document any other water use appliances that may exist in the residence such as dishwasher, evaporative cooler, spa and so on.

Outdoor

- Check irrigation system for leaks, use of irrigation timers, and proper irrigation times;
- Review or develop customer irrigation schedule.

- Provide customer with evaluation results and water saving recommendations; leave information packet with customer.
- For those customers who are reluctant to having staff conduct an onsite survey, offer a self survey kit. The self survey kit will include the City forms and a description to walk the customer through the water audit process. The form enclosed in the kit will allow the customer to record their fixture flow rates for comparison to currently available low water use fixtures and allow the customer to return the completed form for a free water conservation kit distributed under DMM 2. The self survey kit will include the following:
  - Toilet tabs to detect toilet leaks,
  - Shower flow rate detector bag,
  - Self Water Audit instructions and forms,
  - Educational material such as water savings tips, the significance of the EPA Water Sense certification, and
  - Promotional material for incentives and rebates the City provides.
- Maintain survey information and track monthly customer use and information to ensure accuracy and for use in evaluating DMM effectiveness.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

DMM implementation will follow the below schedule:

1. Within first six months, identify the target group of customers to market this and other DMM's as described in the description of this DMM.
2. Within first year, conduct the marketing phase as part of this DMM through mailings and phone contacts and through other marketing media described in DMM 7.
3. Continue marketing efforts until one percent (1%) of the total number of connections has completed a residential survey as described in this DMM within the reporting period.

Tracking and Documentation

To track implementation of this DMM the following information should be gathered. This information will be summarized in the UWMP updates and used in assessing effectiveness of this DMM.

1. Number of single-family residential accounts in service area.
2. Number of multi-family residential accounts in service area.
3. Number of single-family residential surveys offered during reporting period.
4. Number of single-family residential surveys completed during reporting period.
5. Number of multi-family residential surveys offered during reporting period.
6. Number of multi-family residential surveys completed during reporting period.
7. Maintain survey records for all surveys conducted.
8. Track costs on a per survey basis and cumulative basis. Costs include, staff time during survey, administrative time tracking and updating account information, repairs done, and plumbing retrofit devices installed.
9. Coordinated tracking activities with DMM's 2, 6, 7, and 14.

Estimate of Current Conservation Savings

Current conservation savings of this DMM are estimated by conducting the following:

The average difference in historic and post survey water use data is estimated to be the Gross Savings in water use. The Gross Savings must be reduced by the estimated savings from other DMM's resulting from the survey to provide the Net Savings for this DMM. Savings from the other DMM's will be calculated and tracked under their respective DMM however, are also used to estimate the savings in this DMM. Calculate and compile the savings estimates for all measures conducted during the survey (retrofits) and others which have materialized after the survey (toilet and/or washing machine replacements). Take the Gross Saving acquired from historic and post survey water use data and subtract the estimated savings from all other DMM's resulting from the survey. This is your estimated Net Savings. The Net Savings is a result of outdoor use reduction, leak mitigation conducted during the survey and overall changes in water use behavior as a result of the educational aspect of the survey. The net savings and the costs

tracked over the reporting period will be used to make a direct comparison to costs of providing water to the service area. The following example demonstrates how to calculate the water savings estimates.

Determine the average daily use one month prior the Survey	gal/day prior	Line 1
Determine the average daily use one month after the Survey	gal/day after	Line 2
Gross Savings: Subtract line 2 from line 1	**gal/day savings**	Line 3
Savings from other DMM's	gal/day other DMM's	Line 4
Net Savings: Subtract line 4 from line 3	**gal/day net savings**	Line 5

Effectiveness:

Percent Savings: Divide line 5 by line 1 then multiply by 100	percent savings	%

Evaluation of Effectiveness of DMM

Effectiveness shall be evaluated by use of CUWCC conservation savings table provided below with comparison to net savings calculated for this DMM.

	Pre-1980 Construction	Post-1980 Construction
Low-flow showerhead retrofit	7.2 gpcd	2.9 gpcd
Toilet retrofit (five year life)	1.3 gpcd	0.0 gpcd
Leak repair	0.5 gpcd	0.5 gpcd
Landscape survey (outdoor use reduction)	10%	10%

The calculated Net Savings for this DMM should conserve at least 10% of the total monthly use. At the end of the reporting period, if actual water savings fall significantly lower than the estimated values, the DMM shall go through a Cost-Benefit analysis to determine if this measure is economical.

6.2.2 DMM 2 – Residential Plumbing Retrofit

This DMM replaces high water use fixtures with low-volume retrofit plumbing devices. These devices range from toilet water displacement bags to faucet aerators. The devices are typically installed during a water survey however are available to the public upon request.

DMM Description

The Residential Plumbing Retrofit DMM targets replacement of old high water use plumbing fixtures with new high efficiency or low flow fixtures, in coordination with DMM 1 and 7. Through DMM implementation described below, the City will offer the following plumbing retrofit components:

- Toilet displacement bags,
- New toilet flap valves,
- Low-volume shower heads, and
- Low-volume faucet aerators.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

The following steps are necessary to implement this DMM:

1. Allocate appropriate funds for this DMM.
2. Define water conservation staff to work event booths, respond to telephone and front desk inquiries for conservation kits.
3. This DMM is an extension of DMM 1 in such that a retrofit kit may be installed, if needed, during a residential survey.
4. Identify single-family and multi-family residences constructed prior to 1992. Develop a targeting and marketing strategy to distribute or directly install high-quality, low-flow showerheads (rated 2.5 gpm or less), toilet displacement devices (as needed), toilet flappers (as needed) and faucet aerators (rated 2.2 gpm or less) as practical to residences requiring them. The strategy may contain the following information:
   - Estimate the pre-1992 constructed residential customer population (number of people) to be the target of the coordinated marketing effort in this DMM. Additional prospective recipients of this measure will be identified through direct contact at events booths, and surveys conducted in DMM 1.
5. The goal of this DMM is to actively market, distribute and install plumbing retrofit devices as appropriate for high water use fixtures present in the residential sector. This DMM will be maintained until it can be demonstrated that 75% of single-family residences and 75% of multi-family units are fitted with high-quality, low-flow showerheads.
6. Continue marketing efforts until 1 percent (%) of the total number of residential connections has been fitted with a retrofit device as described in this DMM annually.
7. In addition to direct contact marketing conducted in DMM 1 additional marketing should be coordinated with DMM 7 to include additional forms of communication. Bill stuffers, ads, events booths, online content, and physical posters placed in public

areas are alternative methods of communicating the availability of retrofit devices and should be evaluated for execution as part of DMM 7.

8. Compile and maintain an inventory of water retrofit kits for direct distribution which include high quality fixtures that are EPA WaterSense® certified.

Tracking and Documentation

To assess the progress of the DMM the following information should be gathered. This information will also be summarized in the UWMP updates.

1. The number of the target population of pre-1992 single-family residences and multi-family units provided showerheads and other water saving devices.
2. The estimated percentage of pre-1992 single-family residences and multi-family units in service area fitted with low-flow showerheads and other water saving devices.
3. Maintain a list of customer accounts fitted with retrofit devices to track water savings. Minimum information necessary to evaluate the effectiveness of this DMM includes the following:
   - Number of people in the household.
   - Number of fixtures.
   - Age of toilet (if known).
   - Number and type of devises delivered and/or installed.
   - Name, address and account number.
4. Track device costs and staff time conducted for this DMM.

Evaluation of Effectiveness of DMM

Effectiveness shall be evaluated by use of CUWCC conservation savings table provided below and actual water use records for those accounts which have received retrofit devices by direct distribution or installation during a residential survey.

Historic and post retrofit device water use will be tracked to determine if retrofit devices saving are realized according to CUWCC table.

If actual water savings fall significantly lower than estimated values by the CUWCC table, the DMM will be evaluated. Evaluation should assess device retention rates, actual water savings, customer participation, costs and benefits. Consideration should be given to market saturation and previous conservation efforts.

Estimate of Current Conservation Savings

For those recipients who received retrofit devices via a residential survey or self survey, the savings can be directly calculated and tracked from survey results.

For customers receiving the retrofit devices through direct distribution or pick up, savings estimates will be estimated by use of the CUWCC table below and compared with monthly use data. The table shows the expected daily water savings per capita in a residence if a showerhead retrofit or toilet retrofit of a new flapper and displacement bag installed.

	Pre-1980 Construction Savings	Post-1980 Construction Savings
Low-flow showerhead retrofit	7.2 gpcd	2.9 gpcd
Toilet retrofit (five year life)	1.3 gpcd	0.0 gpcd

6.2.3 DMM 3 – System Water Audits, Leak Detection, and Repair

System water losses are a result of leaks through cracked pipes, damaged appurtenances, faulty joints, illegal uses such as withdrawals from hydrants without explicit approval or permitting and through other non-revenue uses such as metering errors. Water loss through distribution system leaks, does not register at the customer meter for subsequent billing. This water loss translates to lost revenue that is used to recoup the operational investment made in the supply of potable water. To minimize the amount of lost revenue, utilities typically target an acceptable amount of water loss as determined by the balance of non-revenue generating water losses to operational costs required to track down system water losses.

The City repairs all leaks in the distribution system as soon as they are detected. All leaks that are reported by customers or meter readers are investigated and repairs are made. The City's unaccounted water use was 4% for 2007. The expected unaccounted water use for a water system is on average 5-10%; therefore the current operation for leak detection and repair is sufficient.

DMM Description

The System Water Audit, Leak Detection, and Repair DMM will consist of the following with implementation as described below:

- System tracking of water production and use and an assessment of water losses as a percentage of production,

Schedule and Steps for Implementation

Implementation shall consist of at least the following actions:

1. Annually (April) complete a prescreening system audit to determine the need for a full scale system audit. The prescreening system audit shall be calculated as follows:
   - Determine total metered sales for previous year;
   - Determine other verifiable water uses from previous year, e.g., construction water, hydrant flushing, fire suppression uses, etc.;

- Determine total annual production into the distribution system;
- Divide metered sales plus other verifiable uses by total supply into the system. If this quantity is less than 0.9, a full scale system audit is indicated.

2. When indicated by the above analysis, the City will perform a complete water audit of the distribution system using methodology consistent with that described in AWWA M36: Water Audit and Leak Detection.
3. Advise customers whenever it appears possible that leaks exist on the customer's side of the meter. This will be done in conjunction with DMM 1, where high water use might indicate a leak.

Tracking and Documentation

To assess the progress of the DMM the following information should be gathered. This information will be summarized in the UWMP updates.

1. Prescreening audit results and supporting documentation,
2. Maintain necessary data on file to verify the values used to calculate verifiable uses as a percent of total production,
3. Maintain in-house records of audit results or worksheets for each completed audit period,
4. Records of physical surveys conducted on the system, and
5. Tracking of all leak repairs with estimates of leakage flow rate in gallons per day.

Evaluation of Effectiveness of DMM

Effectiveness of this DMM is verified by maintaining unaccounted water losses to less than 10% as indicated by the prescreened water audits.

6.2.4 DMM 4 – Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections

The City of Live Oak is 100% metered and bills all customers by volume of use. The City completed retrofitting existing connections in 2006. The 2007 billing rate for domestic water use is presented in Table 6-2.

Table 6-2
2007 Domestic Water Billing Rates

Meter Size	Minimum Charge	Minimum Units	Rate / Units
5/8" – 3/4"	$23.97	2,000	$1.41/HCF
1"	$25.38	2,100	$1.41/HCF
1 ½" – 1 ¾"	$30.78	2,200	$1.41/HCF
2"	$51.41	3,600	$1.41/HCF
3"	$127.35	9,000	$1.41/HCF
4"	$218.69	15,500	$1.41/HCF
6"	$465.07	33,000	$1.41/HCF

The current rate is $1.41 per hcf unit (748 gallons).

DMM Description

For consistency with California Water Code (Section 525b), this DMM refers to potable water systems. A water meter is defined as a device that measures the actual volume of water delivered to an account in conformance with the guidelines of the American Water Works Association.

Schedule and Steps for Implementation

Implementation shall consist of at least the following actions:

1. Require meters for all new service connections.
2. Read meters and bill customers by volume of use.
   - Maintain billing intervals that are no greater than bi-monthly (every two months) for all customers;
   - For each metered connection, perform at least five actual meter readings (including remotely sensed) per twelve month period.

Tracking and Documentation

This DMM allows the City to track use on a per account basis, and analyze savings for each sector and the City as a whole. Additionally this data will allow the City to perform full scale water audits . This section will outline the recommended minimum use data necessary for tracking sector, seasonal and annual water use and describes how each relates to the proposed DMM's.

1. Sectors: The number of accounts for each sector and sub-sector must be tabulated. This includes the number of dedicated landscape irrigation meters. This information will be useful in identifying DMM coverage and market penetration for water saving devices.
2. Seasonal: Metered data should be collected monthly for each sector and compared seasonally (winter vs. summer) to quantify the amount of discretionary use for each

sector. Discretionary use is typically outdoor water used to wash a car, irrigate landscape and the like. Data gathered and analyzed for seasonal use will assist in:

- Developing irrigation water budgets,
- Residential leak detection if compiled with metered data captured by a data logging water meter,
- The ability to perform follow up tracking for DMM water savings and effectiveness,
- The ability to perform system wide leak detection when comparing verifiable uses to well production data,
- Quantify seasonal peak demand savings obtained from implementing DMM's,
- Developing a marketing list of high use customers, and
- Educating the customer on actual water use.

3. Annual: Metered data collected and analyzed annually will help quantify City wide and Sector savings obtained from all programs implemented. The City can use this data to keep the public informed of conservation progress

Estimate of Current Conservation Savings

As the City of Live Oak is 100% metered and bills all customers by volume of use, no reduction of demand is expected.

6.2.5 DMM 5 – Large Landscape Conservation Programs and Incentives

Large turf areas such as parks, cemeteries, greenbelts and golf courses have an irrigated area of one or more acres. Large landscape owners are more likely to participate in a conservation program as irrigation makes up most if not all of their water demand. A reduction in water use would result in a lower utility bill the landscaper pays in volumetric fees and likewise save the utility water, pumping energy and provide additional supply for peak use periods. A large landscape DMM will assist in educating the large landscape operators, provide an irrigation survey and establish a water budget for those accounts with dedicated landscape meters.

DMM Description

The large landscape conservation program, as described below, applies to large landscape areas greater than 2 acres, including CII accounts (CII users are commercial, industrial, or institutional service) with mixed use meters and landscape accounts with dedicated meters. This DMM consists of developing, tracking, and accounting for irrigation water use at these large landscape accounts through the use of irrigation budgets based on site surveys with follow-up visits. Water conservation is achieved through this DMM by increasing irrigation efficiency at large landscape accounts and reducing water waste.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation of large landscape conservation program shall consist of at least the following actions:

1. Define the funding source and allocate appropriate funds for this DMM.
2. Define Water Conservation staff to conduct surveys.
3. Implement a marketing campaign, similar to DMM 1 by marketing large landscape water use surveys to commercial/industrial/institutional (CII) accounts with mixed-use meters servicing landscapes larger than 2 acres.
   - Each reporting period, directly contact via letter or telephone not less than 1% of CII accounts with mixed-use meters and offer water use surveys. Continue marketing efforts until 90 percent (%) of the total number of connections in the CII sector has completed an outdoor survey as described in this DMM within the reporting period.
   - Develop or identify marketing material to be used for initial contact, during surveys and follow-up to surveys.
4. Compile DMM specific materials such as tools, hardware and software if applicable.
5. Revise current landscaping standards to meet or exceed State mandated landscaping guidelines for future and existing development or adopt the updated Model Water Efficient Landscape Ordinance by January 2010.
6. The City will provide non-residential customers with support to improve their landscape water use efficiency. Support shall include, but not be limited to, the following:
   - Accounts with Dedicated Irrigation Meters
     - Identify accounts with dedicated irrigation meters and assign ETo-based water use budgets equal to no more than 70% of reference evapotranspiration per square foot of landscape area plus a reasonable leaching fraction based on soil type (e.g., 10 to 20%). (CUWCC 2008).
     - For customers exceeding established water budgets and as a tool of measuring performance, require an annual irrigation system analysis to be submitted to the City for review. The irrigation system analysis consists of performing the same

procedures and recording the same system information as would be completed during a staff survey.

- ➢ Provide notices each billing cycle to accounts with water use budgets showing the relationship between the budget and actual consumption. The City may choose not to notify customers whose use is less than their water use budget.
- ➢ Offer landscape surveys as described in sub-section 7 below.

– Commercial/Industrial/Institutional Accounts with Mixed-Use Meters or Non-Metered

- ➢ This section of the DMM will focus on CII accounts serviced by a mixed use meter irrigating an accumulated landscaped area greater than 2 acres.
- ➢ Compile CII user account information and historical water use data. Determine the difference in water use during summer months when landscape irrigation is conducted and winter months when no irrigation occurs (Baseline). Use this information to analyze and prioritize the marketing efforts described above and for educating the customer on use during the survey.
- ➢ Offer a landscape survey described in sub-section 7 below.
- ➢ Encourage the installation of dedicated landscape irrigation meters for mixed use systems.

– Offer the following measures when cost-effective:

- ➢ Training (multi-lingual where appropriate) in landscape maintenance, irrigation system maintenance, and irrigation system design.
- ➢ Financial incentives to improve irrigation system efficiency such as loans, rebates, and grants for the purchase and/or installation of water efficient irrigation systems.

– Provide follow-up to water use analyses/surveys to discuss and reiterate the findings and recommended improvements resulting from a survey. Follow-up will consist of a letter, phone call, or site visit where appropriate.

– New or Change of Service Accounts: Provide information on climate-appropriate landscape design, efficient irrigation equipment/management to new customers and change-of-service customer accounts.

7. Large Landscape Survey: Surveys will consist of the following components

– Discuss the purpose of the survey. This will include the savings potential for the City, community, and for the recipient of the survey (benefits). Also discuss the consequences of maintaining a non-efficient irrigation system. Describe the step to be taken during the survey and why they are important.

- Review the historical water use data gathered with the survey recipient and explain the magnitude of savings potential by maintaining their irrigation system.
- Landscape evaluation: Evaluation will be conducted by recording landscape area, features, plant zones, total irrigable area, irrigation system check, and distribution uniformity (DU) analysis.
- Results: Discuss the findings of the survey, review or develop irrigation schedules, as appropriate, provide conservation recommendations, and leave information packet on rebates or incentives if available.
- Post survey follow-up: A post survey follow up should be conducted. The follow up will track the water use data before and after the survey and secondly the survey recipient should be contacted via phone or letter reminding them of the recommendations and provide a review of the results.
- Track survey offers, acceptance, findings, devices installed, savings potential, and survey cost.

8. Options:
   - Install climate appropriate water efficient landscaping at City facilities, and dual metering where appropriate.
   - Provide customer notices prior to the start of the irrigation season alerting them to check their irrigation systems and make repairs as necessary. Provide customer notices at the end of the irrigation season advising them to adjust their irrigation system timers and irrigation schedules.
   - Require by ordinance of all large landscaped areas regardless of source an annual irrigation system analysis to be conducted and submitted to the City for review by the conservation coordinator.

Tracking and Documentation

To assess the progress of the DMM the following information should be gathered. This information will be summarized in the UWMP updates.

1. Dedicated Landscape Irrigation Accounts:
   - The City shall preserve water use records and budgets for customers with dedicated landscape irrigation accounts for a period of not less than one reporting periods. This information may be used to assess effectiveness for this particular type of account.
     - Number of dedicated irrigation meter accounts.
     - Number of dedicated irrigation meter accounts with water budgets.
     - Aggregate water use for dedicated landscape accounts with budgets.

- Aggregate budgeted water use for dedicated landscape accounts with budgets.

2. Mixed Use Accounts:
   - Number of mixed use accounts.
   - Number, type, and dollar value of incentives, rebates, and no, or low interest loans offered to, and received by, customers.
   - Number of surveys offered.
   - Number of surveys accepted.
   - Estimated annual water savings by customers receiving surveys and implementing recommendations.

Evaluation of Effectiveness of DMM

Evaluation should assess actual water savings, customer participation, costs and benefits and the following for each type of connection:

- Dual metered: Number of times the customer's use exceeds 100% of the established water budget.
- Mixed metered: Annually, for each Large Landscape account, determine if water savings are at or greater than 15% of baseline.

6.2.6 DMM 6 – HIGH-EFFICIENCY WASHING MACHINE REBATE PROGRAM

Washing machines make up 21.7% of the total indoor residential water use (Mayer et al, 1999). Replacing conventional top load high volume washing machines with horizontal axis front loading washing machines have been found to conserve water by as much as 38% per load (Vickers, 2001). Although high efficiency washing machines save the consumer more money over the life of the appliance when compared to conventional washing machines, initial sticker price and unfamiliarity tend to be main barriers withholding consumer from purchasing High Efficiency Washing Machines (HEWMs).

DMM Description

This DMM is based on providing a financial incentive for customers in the City's utility service area to switch to HEWMs. The incentive will allow customers to upgrade existing conventional washing machines to high efficient washing machines to benefit both the customer and utility through reduced water use.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or

- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation shall consist of at least the following actions:

1. The City shall offer a financial incentive in the amount not less than $50, for the purchase of high-efficiency clothes washing machines (HEWMs) meeting a water factor (WF) value of 6.0 or less and modified energy factor (MEF) of 2 or greater. These factors represent standards which the Department of Energy (DOE) has declared as upcoming regulatory performance standards to be enacted by July 1, 2011 as shown in the figure below. These standards are chosen for the HEWM incentive program to expedite the transition from pre-2007 and non-Energy Star models to HEWMs whose performance standards are higher than the current standards.

	Current ENERGY STAR Criteria *as of January 1, 2007*	ENERGY STAR Criteria *as of July 1, 2009*	ENERGY STAR Criteria *as of January 1, 2011*
ENERGY STAR Criteria	MEF ≥ 1.72 WF ≤ 8.0	MEF ≥ 1.8 WF ≤ 7.5	MEF ≥ 2.0 WF ≤ 6.0

Courtesy of Energy Star: Program Requirements and Criteria for Cloths Washers as of March 7, 2008

2. Any financial incentive offered shall be not less than the marginal benefits of the water savings, reduced by the necessary expense of administering the incentive program. Incentive levels shall be calculated by using methods found in A Guide to Customer Incentives for Water Conservation prepared by Barakat and Chamberlain for the CUWA, CUWCC, and US EPA, February 1994.

3. Determine the maximum cost effective financial incentive to be offered to utility customers.

4. Allocate funds and resources for the DMM.

5. Develop Policy that outlines terms and conditions, eligible products, eligible customers, method of incentive transfer and tracking.

6. As part of other marketing strategies or independent of other DMM's develop a marketing strategy to target customers with washing machines whose modified energy factors (MEF) are less than 1.72 and water factor (WF) greater than 8.0.

Tracking and Documentation

The City shall provide documentation for all of the following items:

1. The quantity of single-family and multi-family dwelling units in the agency service area.

2. The quantity and value of financial incentives issued for HEWMs offered.

3. Average or estimated administration and overhead costs to operate the program.

Evaluation of Effectiveness of DMM

Effectiveness of the incentive program will assess customer participation, water savings, costs, and benefits. Savings estimates provided below assume the units have a useful life of 14 years and the HEWMs are operated in the utility service area throughout its useful life.

Estimate of Current Conservation Savings

Gross water savings (gallons) from financial incentive programs that result in the purchase and installation of High Efficiency Washing Machines with water factors equal to or less than 9.5 are calculated using the following formula:

$$GWS = 14\ yr \times \Sigma_i N_i \times (13.3 - i) \times 1{,}170 \text{ gallons per year}$$

Where:

N = Number of machines replaced.

i = Water factor, defined as less than 8 until June 1, 2009, and less than 7.5 until January 1, 2011.

13.3 = Baseline WF for washers sold in 1994, as supplied to DOE by the Association of Home Appliance Manufacturers (AHAM).

14 yr. = Assumed average useful life of residential washers. (Based on information from the Bern Kansas study).

1,170 gallons/year = Average change in water use for a unit change in water factor. This value was developed by the California Energy Commission.

Net water savings (gallons) from financial incentive programs shall be calculated using the following formula:

$$NWS = GWS \times (1 - FR),$$

Where: FR is the estimated rate of free ridership for this DMM and is estimated to be approximately 10% as determined by other utility reports. Free ridership for this program is an assumed percentage of customers who have planned or will purchase a water conserving device even if a rebate program was not implemented. A rebate program is designed to target those customers who would purchase a less efficient device over a high efficient device based on sticker price. The goal of a rebate program is to target those customers and provide a financial incentive to lessen the financial burden of purchasing a more expensive water efficient device. Free riders reduce the cost effectiveness of the rebate program by using money that is allocated for the target group of customers.

6.2.7 DMM 7 – Public Information Programs

A public information program is a powerful channel of communication between the pubic and the message the City delivers. The key goal to a public information program is to: educate the public on the necessity of conservation; the benefits of conservation; and actions needed to achieve water conservation goals. Secondary benefit is the ability to convey specific DMM

information and if possible conduct business through certain channels such as a processing a rebate application on the City website. There is a variety of medium available to choose from to keep the public informed however at a minimum a conservation webpage should be the made available to promote conservation and support DMM activities.

DMM Description

The City of Live Oak currently does not have a public information program to promote and educate customers about water conservation.

The City understands the importance of educating the public on water conservation and promoting water conservation awareness. The City has a very limited staff and resources to implement a public information program, however the City will consider the following:

An informed public tends to be more responsive to City services and more understanding to the needs of rate adjustments when warranted. This DMM includes communication with the public through various means as described below to promote water conservation, involvement in the UWMP update process, and general awareness of water use and conservation. This program includes development of outreach materials for each targeted DMM effort, providing educational sessions for interested parties, and providing conservation displays and information via community events, bill stuffers and other forms of communication.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation shall consist of at least the following actions:

1. Prepare and implement a public information program to promote water conservation and water conservation related benefits. Components of the program include but not limited to:
    - Conducting workshops to employees, citizens, industrial, commercial institutions, community groups and the media.
    - Producing paid and public service advertising.
    - Provide conservation education via bill inserts.
    - Mass marketing promotion of conservation programs and conservation as a whole.

- Develop online content on the City's website promoting water conservation and city sponsored conservation services. If the City will process their own rebates, make application forms which include equipment and eligibility, available as a downloadable document.

2. Provide information on customers' bills showing use in gallons per day for the last billing period compared to the same period the year before if available.
3. Provide public information to promote water conservation practices, over different forms of media.
4. Coordinate with other government agencies, industry groups, public interest groups, and the media.
5. Develop marketing materials for all other DMM's under this measure. This information should make efficient use of all media types ensuring that each DMM promotion is made available in all materials.

Tracking and Documentation

1. Number of public speaking events relating to conservation during reporting period.
2. Number of media events relating to conservation during reporting period.
3. Number of paid or public service announcements relating to conservation produced or sponsored during reporting period.
4. Types of information relating to conservation provided to customers.
5. Annual budget for public information programs directly related to conservation.

Evaluation of Effectiveness of DMM

As a customer calls, e-mails, or comes in to the City offices and inquiries about a water conservation program, the person receiving the inquiry should ask how the customer heard about the program. This information should be noted for use in evaluating the communication effectiveness of this DMM. This will allow the City the ability to evaluate which forms of communication are most prevalent.

6.2.8 DMM 8 – School Education Programs

Education programs inform younger generations on the life cycle of water and benefits of conservation. Implementing an ongoing education campaign on the K-12 grade level using educational materials, which meet education standards, allows children to learn methods of conservation to apply at home and to reinforce behavioral changes within the household. Additionally, learning about conservation leaves a long lasting impression on the students with the potential of improving their conservation awareness as an adult.

DMM Description

The School Education Programs DMM consists of developing and presenting water conservation materials to K-12 grade classes in the City. This DMM will be coordinated with other related DMM's and will be implemented according to the steps and schedule described below.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation shall consist of at least the following actions:

1. Implement a school education program to promote water conservation and water conservation related benefits to cover at least 1 class in the elementary, 1 class in the middle-school range, and 1 class in the high-school range.
2. Programs shall include working with school districts and private schools in the service area to provide instructional assistance, educational materials, and classroom presentations that identify urban, agricultural, and environmental issues and conditions in the local watershed. Education materials shall meet the state education framework requirements, and grade appropriate materials shall be distributed to grade levels K - 3rd, 4th - 6th, 7th - 8th, and high school.
3. Develop an annual contest promoting water conservation

Tracking and Documentation

1. Number of school presentations made during reporting period for grade levels K - 3rd, 4th - 6th, 7th - 8th, and high school.
2. Number and type of curriculum materials developed and/or provided by water supplier, including confirmation that curriculum materials meet state education framework requirements and are grade-level appropriate.
3. Number of students reached.
4. Number of in-service presentations or teacher's workshops conducted during reporting period.
5. Annual budget for school education programs related to conservation.

Evaluation of Effectiveness of DMM

There are no methods of measuring effectiveness for this DMM.

6.2.9 DMM 9 – CONSERVATION PROGRAMS FOR COMMERCIAL, INDUSTRIAL, AND INSTITUTIONAL ACCOUNTS

This DMM establishes conservation programs implemented on the Commercial, Industrial, and Institutional (CII) sectors.

DMM Description

Conservation programs will be established for CII accounts and will parallel residential measures in such that surveys (indoor/outdoor), and incentive programs may be made available for the CII sector and will be the focus of this measure. Some CII customers may maintain landscaped areas which require a more exhaustive outdoor survey therefore, in those instances the survey effort will be coordinated with DMM 5 Large Landscape Conservation Programs.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation shall consist of at least the following actions:

1. Identify commercial, industrial, and institutional (CII) accounts according to water use. In a similar method as conducted in DMM 1, rank water use among each sub-sector and conduct a marketing campaign until 10% of each sub-sector's accounts are surveyed within 10 years of the date implementation is to commence. Marketing will be via mail, phone, personal site visit and bill stuffers offering complete indoor/outdoor water audits and available rebate/incentive programs.
   - In determining which sector pertains to CII accounts, the following sub-sectors are defined:
     - *Commercial Accounts:* any water use that provides or distributes a product or service, such as hotels, restaurants, office buildings, commercial businesses or other places of commerce. These do not include multi-family residences, agricultural users, or customers that fall within the industrial or institutional classifications.
     - *Industrial Accounts:* any water users that are primarily manufacturers or processors of materials as defined by the Standard Industrial Classifications (SIC) Code numbers 2000 through 3999.
     - *Institutional Accounts:* any water-using establishment dedicated to public service. This includes schools, courts, churches, hospitals, and government facilities. All

facilities serving these functions are to be considered institutions regardless of ownership.

2. CII Water-Use Survey and Customer Incentives Program:

   – Water use surveys will include a site visit, an evaluation of all water-using apparatus and processes, and a customer report identifying recommended efficiency measures, their expected payback period and available agency incentives. Within one year of a completed survey, a follow-up will be completed via phone or site visit with the customer regarding facility water use and water saving improvements.

3. Implementation of a CII High Efficiency Toilet (HET) Incentive Program - This program will accelerate the replacement of existing high-water-using toilets with High Efficient (1.28 gallons or less) Toilets in commercial, industrial, and institutional facilities.

4. CII Conservation Performance Target:

   – Implement this DMM to target an annual water use savings by CII accounts by an amount equal to 10% of the baseline use of CII accounts in the service area over the historical use data available. The target amount of annual water use reduction in CII accounts is a static value to be calculated from the baseline amount of annual use. The baseline will be defined as the average annual use for available historical metered use data provided by CII accounts.

5. Continue marketing efforts until 10 percent (%) of the total number of connections in the CII sub-sectors have completed a survey as described in this DMM within the reporting period.

Tracking and Documentation

1. The number of accounts (or customers) and amount of water use within each of the CII sectors.

2. Track customer contacts, accounts (or customers) receiving surveys, follow-ups, and measures implemented.

3. Customer participant information, including retail water utility account ID's, primary contact information, facility address, facility type, number of toilets being replaced, number of toilets in facility (if available), primary reasons for toilet replacement and program participation (if available).

4. Number of CII HETs incentives processed/installed by CII sub-sector by year.

5. Total program cost by year, including administration and overhead, labor (staff salaries and benefits), marketing, outside services, incentives, and implementation (agency installation, rebate, permitting and remedial costs). Costs for program development and program operation shall be reported separately.

6. Total program budget by year.

7. Description of program design and implementation, such as types of incentives, marketing, advertising methods and levels, customer targeting methods, customer contact methods, use of outside services (e.g., consultants or community-based organizations), and participant tracking and follow up.

8. Description of program acceptance or resistance by customers, any obstacles to implementation, and other issues affecting program implementation or effectiveness.

Evaluation of Effectiveness of DMM

Effectiveness is evaluated by reviewing the pre and post survey water use data for each customer that received a water survey or installed HETs on the premises. Using the base line performance criteria described in this DMM, overall CII saving should be at 10% of the baseline as established by historical average annual metered use data. On a per account basis, the estimated reduction of water should be approximated by the reduction shown in the following section below for each sub-sector type shown.

Estimate of Current Conservation Savings

The estimates provided are from the CUWCC MOU and represent the estimated water savings upon the completion of a survey, retrofit and education provided under this DMM.

Commercial and Institutional water reduction results from DMM's such as Interior and Landscape Water Surveys, Plumbing Codes, and Other Factors (Includes savings accounted for in other DMM's.) Estimated reduction in gallons per employee per day in year 2000 use occurring over the period 1980-2000: 12%.

Industrial water reduction results from DMM's, Waste Discharge Fee, New Technology, Water Surveys, Plumbing Codes and Other Factors (Includes savings accounted for in other DMM's.) Estimated reduction in gallons per employee per day in year 2000 use occurring over the period 1980-2000: 15%.

6.2.10 DMM 10 – Wholesale Agency Programs

Water agencies which treat and sale water to retail agencies or specially formed utility districts at wholesale must also provide conservation assistance to the purchasing utility. The wholesaler shall conduct, fund, and promote workshops to assist the retail agency with the following:

1. Procedures for calculating program savings, costs and cost-effectiveness; and

2. The technical, programmatic, strategic or other pertinent issues and developments associated with water conservation activities in each of the following areas: HET replacement; residential retrofits; commercial, industrial and institutional surveys; residential and large turf irrigation; and conservation-related rates and pricing.

The City of Live Oak does not wholesale water to other retailers therefore this DMM does not apply to the City.

6.2.11 DMM 11 – CONSERVATION PRICING

DMM Description

This DMM promotes water conserving retail water rate structures. When creating a rate case, professional judgments are made to determine whether costs are accounted to a variable or fixed cost center by the staff of the agency. The final water rate case is an accumulation of all the decisions and judgments made by staff and supplemented by the financial projections leading an agency to establish its final water rate recommendation.

In a water, sewer or refuse collection rate increase case, the final rates as recommended by staff must go through ballot approval at a Proposition 218 hearing. Proposition 218 contains requirements for the imposition of a fee or charge for property related services. Procedures for fees and charges are contained in Section 6 of Article XIII D and must be implemented during a rate increase. Paragraph (b) describes the requirements for new, existing, or increased fees and charges, as:

1. Revenues from fees or charges shall not exceed the funds required to provide the service.
2. Revenues from fees or charges shall not be used for any other purpose.
3. The amount of the fee or charge imposed upon any parcel or person as an incident of property ownership shall not exceed the proportional cost of the service attributable to the parcel.
4. No fee or charge may be imposed unless the service is actually used by or immediately available to the owner of the property in question.
5. No fee or charge shall be imposed for general governmental services, i.e., police, ambulance, library, where the service is available to the public at large in substantially the same manner as it is to the property owners.

The 2007 domestic water billing rates are shown in Table 6-3.

Table 6-3
2007 Domestic Water Billing Rates

Meter Size	Minimum Charge	Minimum Units	Rate / Units
5/8” – 3/4"	$23.97	2,000	$1.41/HCF
1”	$25.38	2,100	$1.41/HCF
1 ½” – 1 ¾”	$30.78	2,200	$1.41/HCF
2”	$51.41	3,600	$1.41/HCF
3”	$127.35	9,000	$1.41/HCF
4”	$218.69	15,500	$1.41/HCF
6”	$465.07	33,000	$1.41/HCF

As shown, the City bills its customers by volumetric use. The current rate structure establishes a set minimum usage fee with a flat rate structure for use above the minimum usage volume. The flat rate under the current rate structure does not send a conservation signal to the customers during peak periods. Although volumetric billing under the current rate structure allows the customer to make calculated reductions in discretionary use (i.e. irrigation), it does not provide incentive to reduce usage during peak and critical times when utility costs are most expensive or during critical drought conditions.

This DMM is not intended to supplant this rate setting process, but rather to reinforce the need to establish a strong nexus between volume-related system costs and volumetric commodity rates. Conservation pricing requires volumetric rate(s). The goal of this DMM is to recover the maximum amount of water sales revenue from volumetric rates that is consistent with utility costs (which may include utility long-run marginal costs), financial stability, revenue sufficiency, and customer equity.

Schedule and Steps for Implementation

During the next rate study, the following volumetric rate designs may be consistent with the above definition and should be evaluated for implementation

1. Uniform rate in which the volumetric rate is constant regardless of the quantity consumed.
2. Seasonal rates in which the volumetric rate reflects seasonal variation in water delivery costs.
3. Tiered rates in which the volumetric rate increases as the quantity used increases.
4. Allocation-based rates in which the consumption tiers and respective volumetric rates are based on water use norms and water delivery costs established by the utility

In addition to volumetric rate(s), conservation pricing may also include one or more of the following other charges:

1. Service connection charges designed to recover the separable costs of adding new customers to the water distribution system.
2. Monthly or bimonthly meter/service charges to recover costs unrelated to the volume of water delivered or new service connections and to ensure system revenue sufficiency.
3. Special rates and charges for temporary service, fire protection service, and other irregular services provided by the utility.

Other options are those shown on the CUWCC MOU and are as follows:

Adequacy of Volumetric Rate(s): A retail agency's volumetric rate(s) shall be deemed sufficiently consistent with the definition of conservation pricing when it satisfies at least one of the following two options.

Option 1: Let V stand for the total annual revenue from the volumetric rate(s) and M stand for total annual revenue from customer meter/service (fixed) charges, then:

$$\frac{V}{V+M} \geq 70\%$$

This calculation shall only include utility revenues from volumetric rates and monthly or bimonthly meter/service charges. It shall not include utility revenues from new service connection charges; revenue from special rates and charges for temporary service, fire protection, or other irregular services; revenue from grants or contributions from external sources in aid of construction or program implementation; or revenue from property or other utility taxes.

Option 2: Use the rate design model included with the Municipal Water and Wastewater Rate Manual published by the Canadian Water & Wastewater Association with the signatory's water system and cost information to calculate V', the uniform volume rate based on the signatory's long-run incremental cost of service, and M', the associated meter charge. [Let HCF be annual water delivery (in hundred cubic feet).] A signatory's volumetric rate(s) shall be deemed sufficiently consistent with the definition of conservation pricing if:

$$\frac{V}{V+M} \geq \frac{V'}{V'+M'}$$

The rate design model can be downloaded at www.cuwcc.org/technical.

This calculation shall only include utility revenues from volumetric rates and monthly or bimonthly meter/service charges. It shall not include utility revenues from new service connection charges; revenue from special rates and charges for temporary service, fire protection, or other irregular services; revenue from grants or contributions from external sources in aid of construction or program implementation; or revenue from property or other utility taxes.

6.2.12 DMM 12 – WATER CONSERVATION COORDINATOR

DMM Description

To actively manage the measures outlined in this Section, a water conservation coordinator (WCC) and supporting staff must be identified. The WCC will be charged with overseeing and developing the strategies and procedures of all steps and procedures listed in each DMM. This

person must be personable and maintain a friendly and professional image as a representative of the City as the WCC will be in direct contact with the public. Additionally the WCC must be able to communicate effectively by relaying complex concepts to upper management and City Council as the administrator of the Water Conservation Program.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Until that time, public works staff will be charged with implementing active DMM's according to their respective schedules. Implementation shall consist of at least the following actions:

1. Designation of a water conservation coordinator and support staff (if necessary), whose duties shall include the following:
   - Coordination and oversight of conservation programs and DMM implementation;
   - Preparation of the DMM Implementation Status Report to be included in UWMP updates;
   - Communication and promotion of water conservation issues to agency senior management; coordination of agency conservation programs with operations and planning staff; preparation of annual conservation budget; and preparation of the conservation elements of the agency's Urban Water Management Plan.

Tracking and Documentation

1. Conservation Coordinator name, staff position, and years on job.
2. Date Conservation Coordinator position created by agency.
3. Number of Conservation Coordinator staff.
4. Duties of Conservation Coordinator and staff.

Evaluation of Effectiveness of DMM

Evaluation of effectiveness will consider the goals met under each DMM implementation and schedule and ultimately the overall volume of water savings produced by the active management of the program by the coordinator.

6.2.13 DMM 13 – WATER WASTE PROHIBITION

The most visual forms of wasteful practices occur during residential irrigation and outdoor water use. To combat wasteful use, water waste prohibition in the form of an ordinance informs the customer that water waste is prohibited. A draft no waste ordinance is included in Appendix A.

DMM Description

The City will implement and enforce measures prohibiting water wasting practices such as but not limited to inefficient irrigating, gutter flooding, single pass cooling systems in new connections, non-recirculating systems in all new conveyer carwash and commercial laundry systems, and non-recycling decorative water fountains. The draft water waste ordinance states that no person shall unknowingly waste water. This water waste ordinance shall include the provisions applicable to ensure that water waste is captured even if it is wasted unknowingly to them.

Enforcement will identify wasteful water practices and notify the owner of the violation. At the time of first notification/violation the owner may be solicited for a residential or CII survey as proactive option for the owner to consider. Repeat violation shall be fined at levels deemed appropriate by the City.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

6.2.14 DMM 14 – HIGH EFFICIENT TOILET REPLACEMENT

High Efficient Toilets (HETs) use a maximum of 1.28 gallons per flush (gpf) and save approximately 60% to 75% of water when compared to their high water use counterparts at 3.5 and 5.0 gpf. In this measure, older 3.5 and 5.0 (gpf) toilet fixtures in residences are replaced with 1.28 gpf fixtures. The US Environmental Protection Agency (USEPA) through WaterSense® has developed performance standards for high efficient toilet. Additional maximum performance testing was conducted on standard and WaterSense® certified toilets with the intent to verify actual performance with mass loadings, which have been determined to be nearly identical to real world loadings.

DMM Description

This DMM is based on implementing a financial incentive program for customers in the City's utility service area for replacement of higher water use toilets with HETs. The incentive will

allow customers to upgrade existing high water use toilet to high efficient toilets to benefit both the customer and utility through reduced water use.

Schedule and Steps for Implementation

This DMM will be implemented under the following circumstances.

- Upon the City making application to the Department of Water Resources, State Water Resources Control Board, or California Bay-Delta Authority (or successor) for grant or loan funding requiring implementation of demand management measures, or
- By the next year ending in zero or five after the City reaching 3,000 connections or exceeding 3,000 acre feet per year total water production.

Implementation shall consist of at least the following actions:

1. Implement a rebate program which replacing existing high-water-using toilets with high efficient (1.28 gallons or less) toilets in single-family and multi-family residences.
2. The City should offer a financial incentive in the amount not less than $75, for the purchase of a WaterSense® certified HET.
3. Allocate funds and resources for the DMM.
4. Coordinate marketing efforts with DMM 7 to target residences with high water use toilets. Toilets sold after 1994 were required by law to be Ultra Low Flush Toilets (1.6 gpf) therefore, residences which were constructed prior to 1994 would typically contain toilets which use 3.5 gpf or greater.
5. Develop Policy that outlines terms and conditions, eligible products, eligible customers, method of incentive transfer and tracking considering the following components:
   - Eligible products are those HETs which are at minimum WaterSense Certified. To ensure that utility customers are supplied high performing HETs the City may opt to narrow down the eligibility list to those high performing toilets listed in a Maximum Performance Study conducted by a joint effort between the California Urban Water Conservation Council (CUWCC), Alliance for Water Efficiency (AWE), The Canadian Water and Waste Water Association (CWWA) and other sponsoring utilities found here: www.a4we.org/MaP-main.aspx.
   - Eligible customers are those customers utilizing toilets with a flush rate of 3.5 gallons per flush (gpf) or more.
   - The City must identify a method of funding the incentive. This is largely determined by the available technology currently employed and the staff availability. If the City is able to track the incentive program in the utility billing system, the recommended method of funding is via a utility bill credit. This would reduce the administration and paperwork needed to process the credit.

Other methods would allow a voucher to be given to the local appliance stores and or rebates to be processed after the purchase and installation of the HET.

– Methods of tracking the incentive and ensuring that the HET is utilized in the service area to ensure that the City gets the full return on the investment. If the City is able to track incentives via the billing system, this would the most efficient process which it would allow the City to track the accounts which the HETs were installed. Likewise, a follow up inspection may be necessary to verify HET installation.

Tracking and Documentation

1. The number of single-family residences and multi-family units in the service area constructed prior to 1992. Coordinate with DMM 2, as this is part of the marketing criteria.
2. The average number of toilets per single-family residence; the average number of toilets per multi-family unit.
3. The average persons per household for single-family residences; the average persons per household for multi-family residences.
4. The housing resale rate for single-family residences in service area; the housing resale rate for multi-family residences in service area.
5. Estimated water savings per HET replacement.
6. Total program cost by year, including administration and overhead, labor (staff salaries and benefits), marketing, outside services, incentives, and implementation (agency installation, rebate, permitting and remedial costs). Costs for program development and program operation shall be reported separately.
7. Description of program design and implementation, such as types of incentives, marketing, advertising methods and levels, customer targeting methods, customer contact methods, use of outside services (e.g., consultants or community-based organizations), and participant tracking and follow up.
8. Description of program acceptance or resistance by customers, any obstacles to implementation.

Evaluation of Effectiveness of DMM

Evaluation will measure the estimated savings with the actual cost of implementing this measure.

Estimate of Current Conservation Savings

A simplified savings estimate resulting in the installation of an ultra low flush toilet is estimated to be a flat rate of 10.5 gallons per capita day as determined by a survey conducted by AWWARF Residential End Uses of Water, on 1,188 households throughout 12 study sites. This savings estimate was based on the then Ultra Low Flush Toilets with a flush rate of 1.6 gpf therefore the savings for the HET will be greater.

Section 7

Supply and Demand Comparison

7.1 SUPPLY AND DEMAND COMPARISON PROVISIONS

The water supply and demand comparison is presented in Table 7-1. The projected water demand is compared to water supplied from the existing and future wells. The future supply in a single or multiple dry year scenario is assumed to be the same as in a normal year based on the discussion in Section 3. The aquifer appears to have the capacity to supply additional production.

Table 7-1
Projected Normal Groundwater Supply and Demand Comparison[(a)]

Water Supply Sources	2009	2010	2015	2020	2025	2030
Groundwater Supply (AFA)	3,120	5,590	8,070	9,310	11,790	13,030
Projected Water Demand (AFA)	2,100	3,000	5,200	7,400	9,600	11,800
Difference (supply minus demand) (AFA)	1,020	2,590	2,870	1,910	2,190	1,230
Percent of 2009 demand (%)	100	179	259	298	378	418
Difference as % of supply (%)	33	46	36	21	19	9
Different as % of demand (%)	49	86	55	26	23	10

(a) Supply is assumed to be the same for normal and multiple dry year scenarios due to the groundwater basin historically not being affected by drought.

(b) Demands are higher than observed metered demand data due to the inclusion of approved unbuilt demands. Approved unbuilt demands were included because system capacity has been committed to these parcels

The City of Live Oak is pursuing sufficient water supplies to meet customer needs through 2030, and will continue its commitment to conservation programs and new construction efficiency standards. The projected single dry year supply and demand comparison is presented in Table 7-2.

Table 7-2
Projected Single Dry Year Supply and Demand Comparison

	2010	2015	2020	2025	2030
Groundwater Supply (AFA)	5,590	8,070	9,310	11,790	13,030
Projected Water Demand (AFA)	3,000	5,200	7,400	9,600	11,800
Difference (supply minus demand) (AFA)	2,590	2,870	1,910	2,190	1,230
Percent of 2009 demand (%)	179	259	298	378	418
Difference as % of supply (%)	46	36	21	19	9
Different as % of demand (%)	86	55	26	23	10

The projected supply and demand comparison during multiple years is shown in Tables 7-3 through 7-6.

Table 7-3
Projected Supply and Demand Comparison during Multiple Dry Year Ending in 2015

	2009	2010	2011	2012	2013	2014	2015
Groundwater Supply (AFA)	3,120	5,590	5,590	5,590	5,590	5,590	8,070
Projected Water Demand (AFA)	2,100	3,000	3,440	3,880	4,320	4,760	5,200
Difference (supply minus demand) (AFA)	1020	2590	2150	1710	1270	830	2870
Percent of 2009 demand (%)	100	143	164	185	206	227	248
Difference as % of supply (%)	33	46	38	31	23	15	36
Different as % of demand (%)	49	86	63	44	29	17	55

Table 7-4
Projected Supply and Demand Comparison during Multiple Dry Year Ending in 2020

	2016	2017	2018	2019	2020
Groundwater Supply (AFA)	8,070	8,070	8,070	8,070	9,310
Projected Water Demand (AFA)	5,640	6,080	6,520	6,960	7,400
Difference (supply minus demand) (AFA)	2430	1990	1550	1110	1910
Percent of 2009 demand (%)	269	290	310	331	352
Difference as % of supply (%)	30	25	19	14	21
Different as % of demand (%)	43	33	24	16	26

Table 7-5
Projected Supply and Demand Comparison during Multiple Dry Year Ending in 2025

	2021	2022	2023	2024	2025
Groundwater Supply (AFA)	9,310	9,310	9,310	9,310	11,790
Projected Water Demand (AFA)	7,840	8,280	8,720	9,160	9,600
Difference (supply minus demand) (AFA)	1470	1030	590	150	2190
Percent of 2009 demand (%)	373	394	415	436	457
Difference as % of supply (%)	16	11	6	2	19
Different as % of demand (%)	19	12	7	2	23

Table 7-6
Projected Supply and Demand Comparison during Multiple Dry Year Ending in 2030

	2026	2027	2028	2029	2030
Groundwater Supply (AFA)	11,790	11,790	11,790	11,790	13,030
Projected Water Demand (AFA)	10,040	10,480	10,920	11,360	11,800
Difference (supply minus demand) (AFA)	1750	1310	870	430	1230
Percent of 2009 demand (%)	478	499	520	541	562
Difference as % of supply (%)	15	11	7	4	9
Different as % of demand (%)	17	13	8	4	10

Section 8

Water Shortage Contingency Plan

8.1 WATER SHORTAGE CONTINGENCY PLAN

The City does not currently have a water shortage contingency plan. This plan was prepared to be consistent with the provisions of the City's emergency response procedures to implement during an interruption of water supplies including, but not limited to a regional power outage, an earthquake, or other disaster.

8.1.1 WATER SHORTAGE EMERGENCY RESPONSE

The City will implement a water shortage emergency response plan as necessary to maintain potable water supplies to the extent practicable. The water shortage emergency response plan is intended to maintain minimum levels of water supply to meet basic health and sanitation needs during times of water shortage.

In the case of a power failure all the well sites except well number three have diesel engine electric generators. Typically a back-up generator would have enough fuel to run 12 to 24 hours. If a power interruption were to last longer, the generators would need to be re-fueled accordingly, until power was restored.

In 2005, the City constructed a 1.4 million gallon storage tank and pump station to absorb the peak hourly demand in the summer months. This storage tank would serve as back-up supply in an immediate emergency, until the system was brought online or other water supplies were brought in.

The City will identify potable water distribution sites in cases of emergencies. The City can also contact bottled water companies, or licensed potable water haulers in cases of limited emergencies. Canals such as the Live Oak canal and the Sutter Butte Canal contain non-potable water that traverse the community and could be used in extreme conditions with emergency treatment provided. Residents would need to boil or disinfect any non-potable water. Another option for the City is to use local trucking firms to transport water along with the County's fire tanker trucks.

When a water shortage appears imminent, a City water shortage response team would be activated by the City Council, City Manager, or Public Works Director. The team will include the City Manager's Office, Public Works Department, Finance Department, and Planning Department.

8.1.2 PREPARATION ACTIONS FOR A CATASTROPHE

Below is an example of actions the City would undertake if a catastrophe were imminent or declared.

- Determine extent of water shortage
- Activate the water shortage response team
- Monitor existing storage
- Obtain additional water supplies
- Develop alternative water supplies
- Determine where immediate funding will come from
- Contact and coordinate with other agencies
- Put employees and contractors on-call
- Communicate with the public

8.1.3 SUPPLEMENTAL WATER SUPPLIES

There are no identified supplemental water supplies other than using bottled water, or consumers treating non-potable water that is conveyed in canals near the City.

8.1.4 LONG TERM ADDITIONAL WATER SUPPLY OPTIONS

The City will continue to address the supplemental groundwater needs to meet future long term water demand by drilling additional wells according to the City's Water Master Plan. Opportunities for recycled water use will also be further studied.

8.2 WATER SHORTAGE CONTINGENCY ORDINANCE/ RESOLUTION

As stated before the City does not have a no waste ordinance, however a draft ordinance is presented in the Appendix A. A draft resolution to declare a Water Shortage Emergency is also presented in the Appendix B.

8.2.1 RATIONING STAGES AND REDUCTION GOALS

The City developed a three-stage action plan (Table 8-1) to enforce during a declared water shortage. The plan includes voluntary and mandatory rationing, depending on the causes, severity, and anticipated duration of water supply shortages, if known. Action stages may be triggered by a shortage at any time of the year. If it appears that it may be a dry year, mainly due to insufficient precipitation and dropping of the groundwater table, the City can take action in advance of a crisis.

Table 8-1
Water Rationing Stages and Reduction Goals

Stage	Criteria	Water Demand Reduction Goal	Program Type
Stage 1 Minimal	▪ 1 or more of the operational City wells is out of service due to noncompliance with drinking water standards or drop in static groundwater levels	15% Reduction	Voluntary / Mandatory
Stage 2 Moderate	▪ Prolonged Periods of low water pressure. ▪ 1 or more of the operational City wells is out of service due to noncompliance with drinking water standards or drop in static groundwater levels	25% Reduction	Voluntary / Mandatory
Stage 3 Severe	▪ Prolonged Periods of low water pressure. ▪ 1 or more of the operational City wells is out of service due to noncompliance with drinking water standards or drop in static groundwater levels ▪ Extended warm weather patterns typical of summer	35% Reduction	Mandatory

8.2.2 PRIORITY BY USE

Priorities for use of available water during shortages are listed below according to ranking.

1. Minimum health and safety allocations - for interior residential needs (includes single family, multifamily, and mobile homes, and convalescent facilities); and fire fighting and public safety needs;
2. Commercial, industrial, institutional/governmental operations - for maintaining economic base of community;
3. Existing landscaping - trees and shrubs;
4. New demand - proposed construction projects.

8.2.3 HEALTH AND SAFETY REQUIREMENTS

Estimates for interior residential water use provided by the California Department of Water Resources is show in Table 8-2.

These water use estimates indicate per capita health and safety water requirements for various appliances and fixtures. A health and safety allotment of 68 gallons per capita per day (gpcd) is essential for basic interior water use with no habit or plumbing fixture change. However, if there is prolonged water shortage or a disaster, then customers would be required to make changes in their interior water use habits (for instance, not flushing toilets unless necessary or taking less frequent showers). These reductions will be reinforced through a public awareness campaign during periods of threatened water supply.

Table 8-2
Estimated Per Capita Health and Safety Water Consumption

	Non-Conserving Fixtures			Habit Changes			Conserving Fixtures[2]		
Unit	Daily Use	Unit Use	gal/day	Daily Use	Unit Use	gal/day	Daily Use	Unit Use	gal/day
Toilets	5 flushes	5.5 gpf	27.5	3 flushes	5.5 gpcd	16.5	5 flushes	1.5 gpf	7.5
Shower	5 min	4.0 gpm	20.0	4 min	3.0 gpm	12.0	5 min	2.0 gpm	10.0
Washer[1]	12.5 gpcd		12.5	11.5 gpcd		11.5	11.5 gpcd		11.5
Kitchen	4 gpcd		4.0	4 gpcd		4.0	4 gpcd		4.0
Other	4 gpcd		4.0	4 gpcd		4.0	4 gpcd		4.0
Total (gpcd)			68.0			48.0			37.0
					Reduction (%)	*29.4*			*22.9*

1 Reduced washer use results from larger loads.
2 Fixtures include ULF 1.6 gpf toilets, 2.0 gpm showerheads, and efficient clothes washers.

8.3 MANDATORY PROHIBITIONS ON WATER WASTING

As previously mentioned, a no waste ordinance was drafted (Appendix A). The ordinance prohibits various wasteful water uses such as outdoor irrigation during high evaporation times, having leaky sprinklers or fixtures, and washing of hardscapes without first obtaining a waiver. Warnings and penalties are levied for infractions to the ordinance.

8.4 CONSUMPTION REDUCTION METHODS

Examples of consumption reduction methods that could be instituted during a drought period include: use prohibitions (especially for landscape irrigation); additional water conservation enforcement; voluntary rationing, mandatory rationing; flow restrictions; expansion of leak detections and repair programs; installation of water kits, plumbing fixture replacements; restrictions on building permits; installation of pool covers; and water shortage pricing.

8.5 EXCESSIVE USE PENALTIES

Any customer violating the regulations and restrictions on water use set forth in the City's draft no waste ordinance shall receive a written warning for the first such violation. When the City approves the ordinance the City will decide and approve the amount the fines will be for second, and third violations.

8.6 REVENUE AND EXPENDITURE IMPACTS AND MEASURES TO OVERCOME IMPACTS

Water rates need to be set up to enable water suppliers to cover the costs in pumping, storing, treating, and delivering water. Revenues need to be collected to build reserves for future water system repairs, maintenance, and replacement. Water shortages increase costs to the water

supplier by increasing expenses for public educational campaigns, stricter conservation efforts, and facility development. Other costs for repairs, maintenance, and replacement are fixed.

To mitigate the financial impacts of a water shortage, the City would need to rely on reserves and increased water rates, when justified.

8.7 MECHANISMS TO DETERMINE REDUCTIONS IN WATER USE

With normal water supply conditions, water production is recorded daily at each wellhead and reported to the Public Works Facilities Manager.

Reporting escalates with advanced stages of water shortages. During water emergency shortages, production figures would be reported to the Water Services Supervisor hourly, and to the Director of Public Works and City Manager daily. Reports would also be provided to the City Council. If reduction goals are not met, the City Council would be notified so that additional action may be taken (water shortage emergency).

Section 9

Water Recycling

9.1 PARTICIPATION IN REGIONAL RECYCLED WATER PLANNING

The City of Live Oak is not part of a regional group that discusses recycled water planning.

9.2 WASTEWATER COLLECTION AND TREATMENT IN LIVE OAK

The City of Live Oak currently owns and operates a wastewater treatment and collection system. On average the wastewater treatment plant handles an inflow of 0.8 mgd. The sewer service area collects flows from approximately 8,500 people, 70 acres of commercial, and 60 acres of light industrial users. Table 9-1 presents the current and anticipated annual wastewater volumes to be collected for treatment and disposal.

Table 9-1
Wastewater Average Dry Weather Flow (AFA) [(a)]

	2008	2010	2015	2020	2025	2030
WWTP	810	890	1,130	1,420	1,800	2,270

(a) Average dry weather flow (ADWF) estimated assuming a 4.8% growth rate as explained in Section 2.3.

The City will upgrade their treatment plant to meet discharge compliance requirements. The upgraded plant will include secondary treatment by an activated sludge process, and tertiary treatment including filters and UV disinfection.

9.2.1 WASTEWATER TREATMENT PROCESSES

The Live Oak Wastewater Treatment Plant has a capacity of 1.4 million gallons/day (MGD) average dry weather flow (2006). The existing treatment facilities consist of fine screening, aerated treatment ponds and lagoons, and chlorine disinfection with subsequent de-chlorination before discharging disinfected effluent to an irrigation drain (Reclamation District 777 Lateral Drain Number 1). Final effluent can also flow into a detention basin before final discharge into Lateral Drain 1. Lateral Drain 1 is under the jurisdiction of the California Department of Fish and Game. Effluent discharge can be intermittent during the summer months should the plant hold effluent in the ponds to increase treatment. The plant can store approximately 30 days of flow.

9.2.2 REGIONAL WASTEWATER TREATMENT PLANT

The City of Live Oak does not have a regional wastewater treatment plant. However, if the City does decide in the future to regionalize with Yuba City, partially treated wastewater will likely be sent to the Yuba City WWTF where it will be further treated discharged into the Feather River.

9.3 RECYCLED WATER CURRENTLY BEING USED

The City does not currently recycle any of is treated wastewater. The City does not currently have any of the infrastructure to deliver recycled water to for landscape irrigation or industrial uses in the vicinity of the City.

9.3.1 POTENTIAL USES OF RECYCLED WATER

The City is planning to upgrade the existing secondary wastewater treatment plant to a full Title 22 plant, which would allow for the possibility of recycled water. The plant would have the required storage and treatment redundancy. A recycled water distribution system including pumping, distribution pipelines, and storage would also need to be constructed.

With the possibility of the City upgrading the treatment plant and potentially using recycled water, the City could use recycled water for the following:

- Groundwater recharge,
- Irrigation of fodder and food crops,
- Irrigation of parks, playgrounds, school, and other large landscapes, such as golf courses, cemeteries, and freeway landscaping,
- Filling of tanker trucks for fire fighting, dust control during construction projects, and flushing of sanitary sewers,
- Certain commercial and industrial processes (such as cooling towers, etc.).

9.4 PROJECTED USE OF RECYCLED WATER

There is currently no projected use of recycled water for the City of Live Oak. Until the City moves beyond initial considerations for recycling water the recycled water use cannot be projected.

Appendix A

DRAFT – No Waste Ordinance

PROHIBITING WASTEFUL USE OF WATER

It is hereby resolved by the City Council that to conserve the City's water supply for the greatest public benefit, and to reduce the quantity of water used by the City's customers, that wasteful use of water should be eliminated. Customers of the City shall observe the following regulations and restrictions on water use:

1. No customer shall waste water. As used herein, the term "waste" means:

    a. Use of potable water to irrigate turf, ground-cover, shrubbery, crops, vegetation, and trees (agricultural accounts are excluded from the time of irrigation restriction) between the hours of 10:00 o'clock A.M. and 6:00 o'clock P.M. or in such a manner as to result in runoff for more than five (5) minutes;

    b. Use of potable water to wash sidewalks, walkways, driveways, parking lots, open ground or other hard surfaced areas except where necessary for public health or safety;

    c. Allowing potable water to escape from breaks within the customer's plumbing system for more than twenty-four (24) hours after the customer is notified or discovers the break;

    d. Washing cars, boats, trailers, aircraft, or other vehicles by hose without a shutoff nozzle and bucket except to wash such vehicles at commercial or fleet vehicle washing facilities using water recycling equipment.

    e. Use of potable water to clean, fill or maintain decorative fountains, lakes or ponds unless such water is reclaimed.

2. The following restrictions are effective during a declared Water-Shortage Emergency.

    a. No restaurant, hotel, cafe, cafeteria or other public place where food is sold, served or offered for sale, shall serve drinking water to any customer unless expressly requested.

    b. Use of potable water for construction, compaction, dust control, street or parking lot sweeping, building wash down where non-potable or recycled water is sufficient.

    c. Use of potable water for sewer system maintenance or fire protection training without prior approval by the Mayor;

    d. Use of potable water for any purpose in excess of the amounts allocated or each class of service.

3. Other restrictions may be necessary during a declared Water Shortage Emergency, to safeguard the adequacy of the water supply for domestic, sanitation, fire protection, and environmental requirements.

ENFORCEMENT

Any customer violating the regulations and restrictions on water use set forth in this chapter shall receive a written warning for the first such violation. Upon a second violation, the customer shall receive a written warning and the City may cause a flow-restrictor to be installed in the service. If a flow-restrictor is placed, the cost of installation and removal shall be paid by the violator. Any willful violation occurring subsequent to the issuance of the second written warning shall constitute a misdemeanor and may be referred to the County District Attorney's Office for prosecution. The City may also disconnect the water service. If water service is disconnected, it shall be restored only upon payment of the turn-on charge fixed by the Board of Directors.

PENALTY FOR VIOLATIONS

Except as provided in the enforcement section for the first and second violations any person, firm, partnership, association, corporation or political entity violating or causing or permitting the violation of any of the provisions of this section or providing false information to the City in response to City's requests for information needed by the City to calculate consumer water allotments shall be guilty of a misdemeanor punishable by imprisonment in the county jail for not more that thirty days or by a fine not exceeding one thousand dollars or both. Each separate day or portion thereof in which any violation occurs or continues without a good faith effort by the responsible party to correct the violation shall constitute a separate offense and, upon conviction thereof, shall be separately punishable.

APPEALS

Variances from the requirements of this Section may be granted by the Board of Directors only after denial of a variance request by the general manager. Appeals of variance request denials shall be made in writing to the secretary of the Board at least 2 weeks prior to the meeting at which they will be heard. Upon granting any appeal, the Board of directors may impose any conditions it determines to be just and proper. Variances granted by the Board shall be prepared in writing, the furnished to the applicant. The board of Directors may require it to be recorded at applicant's expense.

REMEDIES/CUMULATIVE

The remedies available to the City to enforce this ordinance are in addition to any other remedies available under the City's code or any state statutes or regulations, and do not replace or supplant any other remedy, but are cumulative.

Appendix B

DRAFT – Resolution to Declare a Water Shortage Emergency

DRAFT RESOLUTION OF THE CITY COUNCIL OF THE CITY OF LIVE OAK CITY AUTHORIZING THE PUBLIC WORKS DIRECTOR TO DECLARE A WATER SHORTAGE EMERGENCY

The City Council of the City of Live Oak does hereby resolve as follows:

PURSUANT to California Water Code Section 350 et seq., the Council has conducted duly noticed public meeting to establish the criteria under which a water shortage emergency may be declared.

WHEREAS, the Council finds, determines and declares as follows:

(a) The City is the municipal water purveyor for the Live Oak Water Utility.

(b) The demand for water service is not expected to lessen.

(c) When the combined total amount of water supply available to the City from all sources falls at or below the Stage II triggering levels described in the Urban Water Management Plan, the City will declare a water shortage emergency. The water supply would not be adequate to meet the ordinary demands and requirements of water consumers without depleting the City's water supply to the extent that there may be insufficient water for human consumption, sanitation, and fire protection. This condition is likely to exist until precipitation and inflow dramatically increases or until water system damage resulting from a disaster are repaired and normal water service is restored.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Live Oak hereby directs the Public Works Director to find, determine, declare and conclude that a water shortage emergency condition exists that threaten the adequacy of water supply, until the City's water supply is deemed adequate. After the declaration of a water shortage emergency, the Public Works Director is directed to determine the appropriate Rationing Stage and implement the City's Water Shortage Emergency Response.

LET IT FURTHER BE RESOLVED, that the Council shall periodically conduct proceedings to determine additional restrictions and regulations which may be necessary to safeguard the adequacy of the water supply for domestic, sanitation, and fire protection.

Appendix C

Resolution of Adoption of City of Live Oak Urban Water Management Plan

To be included after plan is adopted.

Sutter County

Groundwater Management Plan

March 2012

WOOD RODGERS

DEVELOPING INNOVATIVE DESIGN SOLUTIONS

Sutter County Groundwater Management Plan

Certificate and Seals

This report and analysis was prepared by Wood Rodgers, Inc. with data and technical assistance provided by the Sutter County Public Works Department - Water Resources Division and the California Department of Water Resources - North Central Region.

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1. INTRODUCTION

1.1. Purpose of Groundwater Management Plan

Sutter County (County) has prepared this Groundwater Management Plan (GMP) with input and direction from County stakeholders, and with financial and technical assistance from the California Department of Water Resources (DWR). Preparing this GMP is one step Sutter County is taking to promote and encourage groundwater users in the County to be responsible stewards of the water resources.

Sutter County's purposes for preparing this GMP are to:

- Summarize the current understanding of the groundwater underlying Sutter County and its role in the County's overall water supply, and make that information publicly available.
- Formulate goals and objectives that can be used as guidelines to help manage groundwater resources to meet current and future demands in Sutter County.
- Establish a plan for the County's involvement in ongoing monitoring and management of groundwater to promote those goals and objectives.
- Maintain eligibility for grant funding administered by the California Department of Water Resources to increase the understanding of the groundwater basins underlying Sutter County.

1.2. Sutter County's Role in Groundwater Management

Sutter County has the authority to adopt and implement this GMP under California Water Code §10750 et seq., which states that a local agency that overlies part of a groundwater basin can "by ordinance, or by resolution…adopt and implement a groundwater management plan…within all or part of its service area," so long as the area is:

- Not served by another local agency, a water corporation regulated by the Public Utilities Commission, or a mutual water company.
- Served by a local agency, when the majority of the agency's governing body declines to exercise its authority to manage groundwater and enters into an agreement with the local agency developing the GMP.

Sutter County's intended role in groundwater management, as discussed in this GMP, is to help coordinate the various groundwater users in the County, and encourage them to be

responsible stewards of the water resources. The County does not have the budget or staff to act as an "enforcer" with regards to groundwater use, and does not intend to do so.

1.3. Plan Area

Sutter County intends this GMP to be relevant for the entire County. Sutter County overlies the south central part of the Sacramento Valley Groundwater Basin, and specifically the Sutter Subbasin and portions of the East Butte and North American Subbasins, as shown in Figure 1. The majority of the County is serviced by water and irrigation districts, reclamation districts, cities, and public utility districts (Figure 2), which have the authority to manage groundwater in their service areas. Unless those entities decline to manage groundwater on their own, and instead enter into agreements with the County, this GMP does not formally apply to those areas. If those entities choose not to adopt their own GMPs, they have the option of taking formal action to adopt the Sutter County GMP for their areas. By doing so, they will fulfill the requirements of the groundwater management provisions of the California Water Code.

Some of the water purveyors in the County have prepared groundwater management plans established under provisions of Sections 10750-10756 of the California Water Code (Assembly Bill 3030). Four of these plans have been submitted to DWR for final adoption.

1.4. Public Involvement in Plan Development

Throughout the development of this GMP, Sutter County solicited public input to help guide the direction and content. Aside from the required public notices and hearings related to the GMP development, Sutter County undertook an extensive public outreach program to encourage public involvement in the GMP development and to solicit public input for the GMP. To help guide the development of the GMP, a Plan Advisory Group (PAG) was formed that included representatives of water purveyors, cities, and the general public (attendance sheets provided in Appendix A)

The Sutter County Water Resource Department and the Board of Supervisors approved a Public Outreach Plan (Appendix B) for the GMP process. The Public Outreach Plan established the following objectives:

- Establish an open process to facilitate stakeholder input.
- Provide information to facilitate stakeholder education on material forming the basis of the GMP.

- Provide a framework by which stakeholders are kept informed of the process, issues, and potential solutions.
- Incorporate public comments throughout the decision-making process.

Various entities – including the Board of Supervisors, Plan Advisory Group, and the general public – were involved in the development, approval, and adoption of the GMP.

While developing the GMP, eleven public meetings were held. The location and time for each of the PAG meetings were advertised in local media. Attendance at each PAG meeting was recorded and a mailing list was created to disseminate meeting times and important information regarding the GMP progress. Participation in the PAG was voluntary and the public was invited to attend and comment at public workshops held in Yuba City. At each of the public workshops, Wood Rodgers, Inc. presented a PowerPoint® presentation of the purpose, scope, and schedule for preparing the GMP, along with educational information related to groundwater, geology, wells, and information about the hydrogeology within the County. The PAG meetings were held in 2008 on June 10, August 14, October 17, and December 9; in 2009 on February 10; in 2010 on June 17, August 19, October 28, and December 15; and in 2011 on April 14[1]and October 20. The Sutter County Water Resources Department hosted a website for the GMP at:

http://www.co.sutter.ca.us/doc/government/depts/pw/wr/gmp/gmphome

All of the presentations and applicable meeting information were posted on the GMP website. Presentations, attendance sheets, and a summary of public comments from the workshops are included in Appendix B.

1.4.1. GMP Survey

The County circulated a voluntary Public Opinion Survey to obtain participation and feedback from stakeholders. The surveys were distributed to interested individuals at the PAG meetings and were also made available for download on the County's website. In order to differentiate between individual well owner concerns and water district concerns, two surveys were distributed. Unfortunately, due to the limited returns, the surveys were not beneficial in identifying countywide concerns related to groundwater.

[1] The reason the meetings extended over four years is that DWR issued a stop work order in 2009 due to uncertainties with the State of California budget. Consequently, the GMP process was temporarily delayed from February 2009 to May 2010. Resumption of the GMP process required approval of a new Notice of Intent and a contract amendment with DWR.

1.5. Issues of Concern

A variety of issues and/or concerns with regard to groundwater and groundwater management have been raised by residents of the County during the development of this GMP. These issues and concerns include the following.

1.5.1. Protect private groundwater rights.

The development of the GMP has raised concerns about how individual groundwater rights will be affected. California State Water Law gives property owners the right to make reasonable and beneficial use of the groundwater resource underlying their property. The GMP does not encroach upon or place any restrictions on groundwater rights. Furthermore, the County does not have the budget or staff to act as an "enforcer" with regards to groundwater use, and does not intend to do so.

1.5.2. Is there enough groundwater to sustain a drought?

Water districts within the County have been able to provide groundwater when surface water supplies were reduced during past droughts. Conversely, the use of groundwater when surface water is in short supply allows the aquifer(s) to recharge when surface water is available and is known as conjunctive use.

Increased use of groundwater in some areas is perceived to be taxing the available supply, and there is concern that wells will go dry during a drought. A related concern is that existing wells may be damaged by increased pumping. This concern is particularly widespread in the southeastern portion of the County, where groundwater is used extensively for irrigation. Additionally, changes in cropping trends to more permanent crops have raised concerns about the ability to reduce groundwater use during drought periods without sustaining substantial economic losses in areas that do not use groundwater conjunctively with surface water.

This concern is understandable given the history of significant groundwater level fluctuations in the southeastern portion of the County during past drought periods. Data also indicate that during wetter periods, or when pumping is reduced, groundwater levels have started to recover. The need for water supply reliability to support water users in the County can be addressed through the conjunctive use/management of available surface water, groundwater, and recycled water supplies. Together, these water sources comprise the irrigation water supply for the County, and can be used in fluctuating proportions to meet demands during different hydrologic (including climatic) and economic conditions. Successful management will also require better coordination among water users, and water users will need to work together to develop strategies for curtailing water use

during drought periods. If intra-county water transfers (transfers from one party to another within Sutter County) are possible, they can become an important water management tool and consideration during these periods.

1.5.3. Are there plans to "export" water out of Sutter County?

There is general concern that projects related to groundwater studies and groundwater management (including this GMP) are somehow related to the desire to "export" water from the County. Those who express this concern feel that the State (and other parties within and outside of the County) cannot be trusted to protect the interests of the community within the County. Currently, under state law, groundwater substitution water transfers are allowed. A groundwater substitution water transfers occurs when an entity with surface water rights makes an agreement to transfer some or all of its surface water to downstream users (by not diverting it), and then pumps groundwater to make up for the "lost source supply" that results from the transfer.

This concern can be somewhat allayed by maintaining local water district control of water management decisions. Also, establishing an open process for discussing groundwater conditions and making management decisions will help the stakeholders within the County have a better understanding of the resources and issues and to voice their concerns and have them addressed.

1.5.3.1. Sutter County Conjunctive Water Use Success (Case Study)

The Department of Water Resources provided the following case study for inclusion in this GMP to demonstrate the effectiveness of conjunctive water use.

"An example of a successful conjunctive use program was implemented by the South Sutter Water District (SSWD or District). The SSWD is located in southern Sutter and western Placer counties, with the Bear River as the northern boundary and stretching southwest between Highway 65 and Highway 70 to Pleasant Grove and Curry Creeks. The District was formed in 1954 to develop, store and distribute surface water supplies and to augment and replenish over-drafted groundwater supplies. Figures 3 and 4 are groundwater level hydrographs illustrating the recovery of groundwater levels after the implementation of the

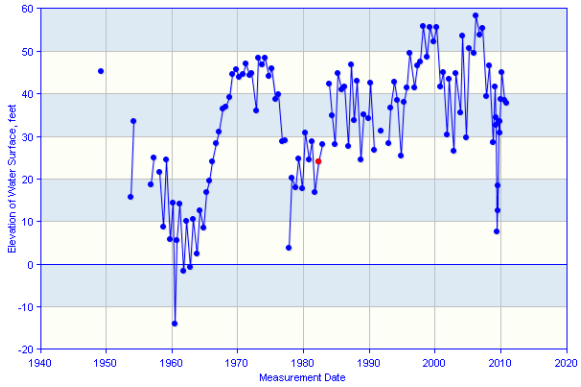

Figure 3 - Hydrograph for Well 13N/5E-30A1M

conjunctive use program. Today SSWD encompasses a total gross area of nearly 64,000 acres, including 57,012 acres that are authorized to receive surface water. According to the District,41,946 acres have actually been irrigated in recent years using a combination of surface and groundwater supplies. By far the majority of those acres grow rice (roughly 34,834 acres, or 83%), while the balance is apportioned between orchards (2,881 acres, or 5%), irrigated pasture (2,088 acres, or 5%), row and field crops (1,742 acres, or 4%) and the remaining 3%, which is fallowed in certain years.

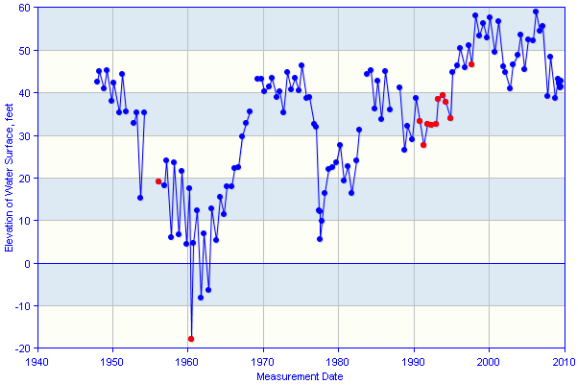

Figure 4 - Hydrograph for Well 13N/4E-13R1M

The enlarged New Camp Far West (NCFW) Reservoir was completed in 1964 with a storage capacity of 104,400 acre-feet (AF). SSWD and Camp Far West Irrigation District (CFWID), formed in 1924, holds the water rights for operating the reservoir. Surface supplies are managed conjunctively with groundwater supplies. The seven (7) megawatts of power generated by the NCFW powerhouse is wholesaled to Sacramento Municipal Utility District. The Federal Energy Commission (FERC) license for NCFW was issued on July 2, 1981.

One and a quarter miles downstream of NCFW Dam (and about 15 miles above the confluence with the Feather River), water is diverted by a diversion dam designed to move 30 cubic feet per second (cfs) north into the CFWID and 380 cfs south into the SSWD. In 1994, SSWD, CFWID, and the Department of Water Resources entered into a settlement agreement to meet the District's obligations under the State Water Resources Control Board's (SWRCB) Water Quality Control Plan for the Bay-Delta. Under the agreement, SSWD agreed to release up to 4,400 AF of water from NCFW, when requested by DWR, in all dry and critical year types. The present water rights require minimum in stream flows below the diversion works of 25 cfs from April 1 through June 30 and 10 cfs from July 1 through March 30. Under the new agreement, SSWD would increase the flow releases to the lower Bear up to 37 cfs in dry and critical years for up to sixty days in July through September.

SSWD receives anywhere from 5,000-20,000 AF of surplus water from Nevada Irrigation District (NID) annually. That water is currently conveyed to SSWD from Rollins Reservoir via the Bear River/Wise Canal system. When completed, SSWD's Canal Expansion project, including related conveyance system improvements, could

well provide previously-unforeseen opportunities for delivering a portion of surplus NID supplies to SSWD directly via the Bear River and NCFW Reservoir."

1.5.4. Will there be taxes or fees for groundwater use?

Concerns have been expressed about the sources of funding for the GMP and other groundwater programs in the County. Funding would be necessary should staff be required to perform new monitoring and evaluation activities or to undertake groundwater investigations. Funding for the latter may be available from DWR and other grant programs, under which this GMP maintains eligibility for the County. Currently, the County assesses fees only for exploratory drilling, well construction, and well destructions, as shown in the following table (Table 1).

Table 1
***Current* Sutter County Fee Assessments (as of January 1, 2012)**

Well Permit	***Fee***
Well Construction	$470.00
Well Destruction	$376.00
Water Exploration and Test Holes	$376.00
Permit Extension (1 year)	$47.00

There is concern about the potential for taxes and fees on groundwater use, and metering of pumps. This GMP does not contain any recommendation to meter groundwater pumping or to enact use-based fees or taxes, although they are considerations and are used in other areas. State law affords property owners the right to make beneficial use of groundwater on their land.

1.5.5. How can we obtain good quality water?

Water quality problems are significant within the County and concerns have been expressed about water quality with regard to salinity, arsenic, and manganese. The hydrogeology of the County as it relates to water quality is not well-understood, and further study will be necessary to develop guidelines for how to obtain good-quality water in different areas of the County, and to determine how to manage groundwater without causing water quality deterioration in areas with otherwise good quality water. As discussed in Section 4.4, this GMP illustrates water quality in different areas of the

County, and shows the geographic areas (and depths) where poorer quality groundwater can be anticipated. As more data becomes available, the County will be able to incorporate it into the existing understanding of the groundwater subbasins.

1.5.6. Is this going to generate new regulations on groundwater?

Concern has been expressed about the potential for additional layers of bureaucracy and regulations on groundwater use. In general, stakeholders recognize a need to better understand and manage groundwater in the County, but have expressed a desire for a "balance" between achieving this objective and minimizing bureaucracy and regulations.

To implement the GMP, an institutional framework (not yet determined) will be needed; however, the intent of this GMP is to minimize the bureaucracy and regulations needed to achieve the goals and objectives of the GMP. The GMP provides a framework and a forum for studying, discussing, and managing groundwater within the County. Ideally, management will be accomplished cooperatively amongst the groundwater users in the County.

2. THE COUNTY

2.1. Physical Setting

Sutter County encompasses approximately 607 square miles (389,443 acres) in the central portion of the Sacramento Valley. As shown in Figure 5, Sutter County is bound by Butte County to the north, Colusa and Yolo Counties to the west, Yuba and Placer Counties to the east, and Sacramento County to the south. The County seat, Yuba City, is located approximately 50 miles north of Sacramento. The 2010 U.S. Census reported that the population of the County in 2010 was 94,737, with the majority of the population residing in Yuba City and Live Oak, and about 25 percent of the population in the rural communities. Land use within the County is principally agricultural, with approximately 318,701 acres in production (Sutter 2010a).

The two main population centers in the County are Yuba City, with 67 percent of the population, and the City of Live Oak, approximately 10 percent of the population (U.S. Census 2010). The remaining County residents live within the small communities of Tierra Buena, Meridian, Rio Oso, Trowbridge, Sutter, Pleasant Grove, Nicolaus, East Nicolaus, Riego, Robbins, or in the vast rural agricultural areas which make up Sutter County. Future major growth areas planned for Sutter County include Sutter Pointe (Measure M). The Sutter Pointe Specific Plan details a large-scale development project that is currently on file with and being processed by Sutter County. This plan area is located in the southern most portion of the County adjacent to the Sacramento County border and a portion of the Placer County border. The plan area includes the development of approximately 7,500 acres into mixed use and residential properties and has been structured to facilitate future incorporation as an independent city (Sutter 2010).

The main transportation routes connecting the County with the region are Highway 99, which runs north-south through the County, California State Route 20, which runs east-west through the County and Highway 113, which runs from the south-west portion of the County and terminates at Highway 99 (connecting Woodland with the County).

Land elevations range between 80 and 20 feet above sea level throughout the County with the exception of the Sutter Buttes, where elevations are more than 2,100 feet above sea level. The lowest land elevations are located towards the southern portion of the County.

Sutter County has abundant surface water, including the Sacramento, Feather, and Bear Rivers, as shown in Figure 5. A number of the water districts in the County (Figure 2) divert and transfer surface water.

2.2. Water Purveyors and Users

Water resources in the County are managed by water purveyors and individual water users who have "hands on" control of both surface water and groundwater for agricultural, urban, environmental, and domestic uses. These water managers represent a complex mix of organized water purveyors, non-organized areas, and areas within National Wildlife Refuges. A brief discussion of each category is presented below.

2.2.1. Water Purveyors

There are 48 water purveyors in Sutter County which provide water service to their customers (Figure 2). These water purveyors include water districts, irrigation districts, reclamation districts, mutual water companies, public utilities districts, and incorporated cities. Additionally, there are many private water users including community service districts (CSD's) and farming interests.

Six water purveyors provide water service not only in Sutter County, but in the counties that share borders with Sutter. They are:

- Reclamation District No. 1004 (Colusa County)
- Biggs-West Gridley Water District (Butte County)
- Butte Water District (Butte County)
- Dry Creek Mutual Water Company (Yuba County)
- South Sutter Water District (Placer County)
- Natomas Central Mutual Water Company (Sacramento County)

2.2.2. Non-Organized Areas

The non-organized areas within the County are not within the boundaries or service area of established water purveyors.

2.2.3. National Wildlife Refuges

The Sacramento National Wildlife Refuge Complex consists of five national wildlife refuges and three wildlife management areas. Portions of Sutter County have been dedicated, both through public and private efforts, as wildlife refuges. Exclusively in Sutter County, the Sutter National Wildlife Refuge has 2,591 total acres, with the majority (83%) located inside the Sutter Bypass. According to U.S. Fish and Wildlife

Service, the refuge "consists of approximately 1,881 acres of seasonal and summer wetlands and approximately 674 acres of unmanaged wetlands, grasslands, and riparian habitats" (USFW 2009).

The Natomas Basin Conservancy also owns nearly 1,000 acres of wildlife habitat/mitigation lands within the southern portion of the County.

2.3. Land Use

The predominant land use within the County is agriculture. The 2008 Sutter County General Plan Technical Background Report estimates that 322,240 acres (83%) of Sutter County is agricultural land. An estimated 44,581 acres (11%) is designated as open space. The remaining 6% of the County is designated as residential, public and vacant, commercial, industrial, and transportation and utilities. As stated above, agriculture dominates land uses within Sutter County. Figure 6 shows the distribution of land uses, with regard to crop type and water source, for the entire County. It is apparent that permanent crops dominate the eastern portion of the County, along the Feather River, while rice and other non-permanent crops dominate the central and western portion of the County.

2.4. Water Use

The amount of water applied for agricultural production and urban or community use has been estimated using information from DWR with respect to unit crop, consumptive use, and applied water, with corresponding losses included and accounted for. Water use within cities and communities was estimated using limited production data from some water purveyors from 2008 to 2010.

2.4.1. Agricultural Water Use

Water use during the 2009 growing season was calculated based on the Sutter County 2009 Crop Report. Estimates of applied water for irrigated agriculture are 1,122,018 AF.

Sutter County's agricultural water usage is approximately 60 percent surface water, 20 percent groundwater, and 20 percent that is irrigated by both surface water and groundwater. Figure 6 illustrates the source of water for crops grown in the County. The predominant source of water for permanent crops is groundwater.

2.4.2. Urban/Community Water Use

Water for urban and community use is from groundwater and surface water. From available DWR records, the minimum urban water use was 1,770 AF in 2010 (records for

all urban water suppliers was not available). Yuba City provides mostly surface water (15,682 AF in 2008) while smaller communities rely exclusively on groundwater.

3. HYDROLOGY AND SURFACE WATER

3.1. Seasonal and Long-Term Hydrology

Annual fluctuations in northern California precipitation directly influence the volume of water flowing in the Sacramento River. Precipitation and climate data from the Western Regional Climate Center (WRCC) suggest the average annual precipitation for the west side of the County (Colusa Station) is 16.40 inches per year and on the east side of the County (Marysville Station), it is 20.96 inches per year. In Nicolaus, the average annual precipitation is 18.27 inches per year. Collectively, average annual precipitation is 18.54 inches per year. Snow-fall within Sutter County is rare, measuring on average 0.01 inches per year. Precipitation is highly variable throughout the State, from year to year. Precipitation usually takes place from October to May and on average no precipitation occurs from June to September. The water year, defined as starting on October 1 and ending September 30, is classified as one of five water year types: critical, dry, below normal, above normal, or wet[2]. Within the past ten years, only two water years were classified as wet and one year was classified above normal. The remaining years were either dry, critical, or below normal. The average annual temperature is approximately 62° F, with an average high of 95.7° F in July and an average low of 37.4° F in January.

Precipitation in the Sierra Nevada, Coast Range, Klamath, and Cascade Mountains contribute to surface water flow and groundwater recharge in the Sacramento River Basin. The general direction of surface water flow is toward the center of the valley, flowing south. Water diversions, evaporation, and groundwater recharge reduce flows as the Sacramento River approaches the Delta.

3.2. Surface Water

Sutter County is located in the Sacramento River Basin, with the Sacramento River on the west and the Feather River on the east. The Sacramento River is the largest river in northern California and drains the northern central part of California. The watershed for the Sacramento River includes tributaries originating in the Sierra Nevada, the Coast Range, and the Cascade Mountains. The main tributaries in Sutter County include the Feather River, Bear River, Dry Creek, Pleasant Grove Creek, Auburn Ravine, and Coon Creek.

During periods of heavy precipitation and runoff, a portion of the flow within the Sacramento River is diverted through the Sutter Bypass. The Sutter Bypass is a man-made feature in Sutter County and was designed to alleviate the flood control system along the Sacramento

[2] http://cdec.water.ca.gov/cgi-progs/iodir/wsihist

River. Aside from the major rivers and tributaries within Sutter County, there are no significant surface water storage reservoirs within Sutter County.

It is important to note that flows in all the major rivers in northern California are managed by dams, e.g. the Feather River by Lake Oroville and the Sacramento River by Lake Shasta. The reservoirs are managed to provide flood protection while collecting runoff from the watershed. Releases from the reservoirs occur from spring through summer to provide irrigation water for agriculture as well as to provide drinking water downstream.

The following discussion provides information on the location, ownership, infrastructure, and an overview of the operational practices of the major water bodies that relate to or are within Sutter County.

3.2.1. The Sacramento River

The Sacramento River is the major surface water feature in Sutter County. Running north-south along the western part of the County, the Sacramento River is the main drainage for the Sacramento Valley Basin on its way to the Delta and the San Francisco Bay. The Sacramento River supports many beneficial uses including recreational, agricultural, and wildlife. The river is currently not used for municipal or domestic water supplies in the County. There are, however, future plans to utilize the Sacramento River, in conjunction with groundwater, to provide municipal water supply to the Measure M Sutter Pointe development (Sutter 2011).

Many tributary streams flow from the mountains on both sides of the valley into the Sacramento River. According to a 2005 report by the Glenn County Department of Agriculture (GCDA), flows in the Sacramento River near Grimes in Southern Colusa County range from 6,500 cfs to 16,900 cfs for the period of record of 1946-2003 (GCDA 2005).

3.2.2. The Feather River

The Feather River is a major tributary of the Sacramento River and outlines a major portion of Sutter County's eastern boundary. The river trends north-south along the northern and central portions of the County to the convergence with the Bear River, where it changes course and flows southwest through the south-central portion of the County until it intersects the Sutter Bypass and the Sacramento River. Like the Sacramento River, the Feather River provides beneficial uses including recreation, agricultural, and wildlife. Yuba City obtains a large portion of its annual water supplies for municipal and domestic use from the Feather River.

3.2.3. The Bear River

The Bear River is a tributary of the Feather River and enters Sutter County from Placer County near the City of Wheatland in Yuba County. It forms the boundary between Sutter and Yuba Counties up to the convergence with the Feather River. The Bear River generally flows west until it converges with the Feather River, approximately one mile upstream from the rural community of Nicolaus. Although smaller than the Sacramento and Feather Rivers, the Bear River also provides beneficial uses that include recreation, agricultural, and wildlife. Discharges within the river are partially controlled by several upstream reservoirs. The Camp Far West Reservoir (located in the counties of Yuba, Placer and Nevada) is the last downstream reservoir on the river and subsequently regulates surface water discharges to downstream users, which has been the source of surface water for a very successful conjunctive water use program for the South Sutter Water District.

3.2.4. The Sutter Bypass

The Sutter Bypass (Bypass) is an artificial flood corridor constructed in the 1930's. As described by the Army Corp of Engineers, "the Sutter Bypass, which began operation in the 1930's, is a leveed portion of the natural floodway in the Sutter Basin. The bypass is south of the Sutter Buttes from Colusa to Verona between the Sacramento and Feather rivers. Flows enter the Sutter Bypass from the Butte Basin at its upper end near Colusa at the Butte Slough. Other flows enter from Wadsworth Canal, interior drainage from pumping plants, and the Sacramento River by way of the Tisdale Weir and Bypass. Flows exit the Sutter Bypass and combine with the Sacramento River, Feather River, Natomas Cross Canal, and Yolo Bypass upstream from the Fremont Weir near the town of Verona"(USACE).

3.3. Seasonal and Long-Term Water Quality

Under the USGS National Water Quality Assessment (NAWQA) Program, the USGS conducted an intensive study of the Sacramento River Basin and collected data between 1995 and 1998. Through the sampling process, the USGS selected indicator streams that were based upon the characterization that "they drain small to intermediate sized watersheds with relatively homogeneous land use and geology" (USGS 1998). The Colusa Basin Drain is located entirely in the Sacramento Valley and was chosen as an indicator stream to determine the impacts of agriculture on stream-water quality (USGS 1998). At the indicator water quality station, Colusa Basin Drain at Road 99E near Knights Landing, it was determined that pH levels were generally on the higher end, with declining suspended sediment concentrations over the two-year sampling period. The higher concentrations of mercury

correlate with suspended sediment because much of the load of total mercury is transported with the suspended material.

The findings of the USGS study also indicated that the water of the Sacramento River and its major tributaries is generally of good quality. As stated in the U.S. Geological Survey Circular 1215:

> "the amount of dissolved solids in the Sacramento River and its major tributaries (Yuba, Feather, and American rivers) was low at all of the sampled locations. Higher median concentrations of dissolved solids occurred at agricultural sites such as the Sacramento Slough and Colusa Basin Drain, but those are diluted upon mixing with Sacramento River water. Nutrient concentrations such as nitrate also were low throughout the Sacramento River Basin, and drinking-water standards for nitrate were not exceeded during the course of this study. The concentrations of Molinate and other pesticides (used in rice farming) measured during this study in the Colusa Basin Drain or in the Sacramento River, represent a significant improvement over concentrations measured in previous years".

3.4. Surface Water Supply Contracts

3.4.1. Settlement Contracts

USBR currently contracts with approximately 145 water districts, water purveyors, or private users for water rights to the Sacramento River. The total amount of water under the settlement contracts is approximately 2.2 million acre-feet and cover a total of almost 440,000 acres of land bordering the Sacramento River and its tributaries between Redding and Sacramento. The Settlement Contracts were originally executed in 1964 with a term not to exceed 40 years. New contracts have been executed with approximately 145 existing Sacramento River Settlement Contracts.

The Settlement Contracts include a Base Supply and Project Water. The Base Supply is the amount that reflects the agreed-upon water right of the respective entity. This is generally regarded as pre-1914 water rights and also water rights perfected after 1914 and reflect water that would be available to the respective entities under "natural" conditions. Project Water represents the amount of water the Bureau of Reclamation agrees to provide from its Central Valley Project (CVP) yield. Under the provisions of the Settlement Contracts both the Base Supply and Project Supply could be reduced by 25 percent of the total contract amount, but only in certain water year types.

3.4.2. Long-Term Renewal Contracts

In accordance with the CVP Improvement Act (CVPIA), the USBR negotiated long-term water service contracts in 2007. According to Section 3404c of the CVPIA, Renewal of Existing Long-Term Contracts requires the USBR to renew any existing long-term repayment or water service contract for the delivery of water from the CVP for a period of 25 years and may renew such contracts for successive periods of up to 25 years each. The USBR anticipates that, "as many as 113 CVP water service contracts, located within the Central Valley of California, may be renewed during this negotiation process" (USBR 2007a).

The long-term renewal contracts, unlike the Settlement Contracts, have no specified reduction in delivery; during critically dry or water-short years, the water supply available from the Project will be allocated among the contractors.

Also, the long-term renewal contracts contain a tiered pricing provision. The Base Supply is 80 percent of the total contract amount, and Tier 1 and Tier 2 supplies represent 10 percent each of the remaining contract amount. Each tier has an incrementally higher water cost. The Tier 1 and Tier 2 water, which is available in most years, is not used due to the incremental higher cost of water.

4. GROUNDWATER

4.1. Groundwater Basins and Subbasins

Sutter County is underlain by the Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater Basin covers a vast area and encompasses the alluvial deposits under the valley floor from the Sierra Nevada Mountains to the east, the Coast Range mountains to the west, the Sacramento-San Joaquin Delta to the south, and the Klamath and Cascade Ranges to the north. The Sacramento Valley Groundwater Basin covers over 5,900 square miles and 10 counties, and has been divided into 18 subbasins. The GMP area is underlain by three groundwater subbasins (Figure 1) as defined by the California Department of Water Resources (DWR) in "California's Groundwater, Bulletin 118 – Update 2003". These subbasins are: the East Butte Subbasin, the Sutter Subbasin, and the North American Subbasin. According to DWR,

"A groundwater basin is defined as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined […] features that significantly impede groundwater flow such as rock or sediments with very low permeability or a geologic structure such as a fault. […]

"A subbasin is created by dividing a groundwater basin into smaller units using geologic and hydrologic barriers or, more commonly, institutional boundaries […]. These subbasins are created for the purpose of collecting and analyzing data, managing water resources, and managing adjudicated basins."

4.2. Hydrogeology

4.2.1. Overview of Groundwater and Geology

Groundwater is water that is underground and below the water table (saturated zone), as opposed to surface water, which flows across the ground surface. There are three main types of subsurface geology where groundwater can exist:

- Hard Rock – Groundwater can be present in cracks or fractures in the rocks.
- Underground Caverns – Groundwater can fill these underground voids.
- Porous Sediments – Groundwater can fill the pore spaces between grains of sand and gravel.

In Sutter County, groundwater exists in porous sediments, alluvial aquifers, or fractured volcanic rock such as in the vicinity of the Sutter Buttes. Figure 7 shows a simplified surface geologic map with the major faults in the County. Sutter County is situated along

the axial portion of the Sacramento Valley Groundwater Basin. The subsurface aquifers consist generally of layers of gravel, sand, clay, and in some cases volcanic ash. The characteristics of different aquifers, and zones within each aquifer, are related to the aquifer materials (sands, gravels, clays, etc.). Within a single aquifer zone, nearby wells with similar construction can have very similar well yields and water quality. It should be noted that many of the geologic formations that make up the alluvial aquifers are continuous units that are also present in other counties as discussed.

In the northern portion of Sutter County, the geologic setting changes rapidly from the stratigraphic succession observed in the rest of the County. A thick sequence of volcaniclastic sediments derived from the Sutter Buttes volcanic epoch form a volcanic fan apron of alluvial deposits around its perimeter. These deposits have been characterized recently by DWR as consisting largely of gravel, sand, silt, and clay. These deposits are observed at ground surface around the Buttes, and may extend up to a 15 mile radius in the subsurface (Springhorn 2008). Sediments deposited under marine sedimentary processes are also observed at ground surface and at shallow depths in the subsurface around the Buttes. These deposits were elevated from depth to their current position during the emplacement of the volcanic intrusion which formed the Sutter Buttes. Water quality in these sediments is generally poor and deteriorates with depth.

There is a large amount of hydrogeologic data available in the Sacramento Valley which has been widely studied, and groundwater is continuous within specific aquifer zones (although discontinuous between different aquifer zones) over large areas within the Sacramento Valley.

4.2.2. Status of Understanding of Regional and Local Geology

The geology of the Sacramento Valley has been studied for at least 95 years, and much has been learned over this time. However, there are still many areas of active study and debate. In Sutter County, areas that are not well-understood and/or are actively being studied include:

- The connection between the Coast Range-sourced Tehama Formation and the analogous Sierra Nevada-sourced deposits, and where this interaction occurs.
- The possible existence of subsurface barriers to groundwater flow within the County.
- The source of poor water quality in parts of the County.

4.2.3. Regional Geology and Structure

The Sacramento Valley Groundwater Basin is a north-south trending structural trough which is filled with layers of sediments. The stratigraphic succession of the basin deposits, from oldest to youngest (deep to shallow), depict a regional change in depositional environment from one dominated by marine sedimentary processes to that of continental (alluvial) processes. The deepest portions of the basin generally consist of marine sedimentary rocks, ranging in age from Late Jurassic to early Miocene (160 million years ago to 24 million years ago). These marine deposits are overlain by younger alluvial and locally prominent volcanic rocks of early Miocene to Holocene age (Harwood and Helley 1987). Within the Basin, these deposits are disrupted by deformational stresses derived from east-west compressional forces associated with regional uplift along the western margin of the valley and extensional forces to the east, within the Basin and Range Provenance (Harwood and Helley 1987). Over time, these forces have applied great stresses and strain on valley deposits, creating complex and diversely-oriented fold and fault structures.

The prominent fault system that occurs in Sutter County is the Willows Fault. The Willows Fault is an active northwest-trending fault that dips steeply to the east and shows reverse displacement, meaning the ground east of the fault has moved up relative to the west side. The Willows Fault enters into the County from Colusa County southwest of the Sutter Buttes and extends to the southeast portion of the County towards Sacramento.

The most prominent and recognizable geologic feature in Sutter County are the Sutter Buttes. The Sutter Buttes are composed of late Cenozoic volcanic rocks that rise over 2,000 feet above the Sacramento Valley floor. The Sutter Buttes formed between 2.4 and 1.4 million years ago as magma at depth was injected into the overlying Cretaceous and Tertiary rocks, causing deformation in the form of faulting, folding, and uparching (Harwood and Helley 1987).

4.2.4. Regional Stratigraphy

The prominent non-marine, fresh water-bearing stratigraphic units found within the East Butte, Sutter, and North American Subbasins include (from youngest to oldest):

- Recent Alluvial Deposits (stream channel, basin, and flood plain);
- the Modesto Formation;
- the Riverbank Formation;

- the Sutter Buttes Rampart;
- the Victor Formation;
- the contiguous Laguna, Tuscan, and the Tehama Formations;
- the Mehrten Formation; and
- the informally named Sutter Formation (Springhorn 2008).

Except for the Sutter Formation, the stratigraphic descriptions presented herein are based upon the California Department of Water Resources "Bulletin 118 – California's Groundwater" and are shown in the geologic cross-sections (Figure 8). The location of the cross-section is shown in Figure 7.

Locally, the stratigraphic succession observed in each subbasin differs slightly; therefore, each subbasin and its associated geologic setting are described separately with regard to their relative positions and occurrences in the specific subbasin.

4.2.4.1. East Butte Subbasin (Basin Number 5-21.59)

The northern section of Sutter County is underlain by the East Butte Subbasin. The East Butte Subbasin is bounded by the Sutter Buttes to the south, Butte Creek to the west and northwest, the Cascade Mountain range to the northeast, and the Feather River to the southeast. The East Butte Subbasin aquifer system consists of late Tertiary to Quaternary aged deposits comprised of Sierra and Cascade sourced material, and in the southern portion of the subbasin around the Sutter Buttes, by volcanic and volcaniclastic rocks. The geologic formations that comprise the East Butte Subbasin are (from youngest to oldest):

- Recent Alluvial Deposits;
- the Pleistocene aged Modesto and Riverbank Formations;
- the Sutter Buttes Rampart; and
- the Tertiary aged Laguna and Tuscan Formations.

Recent Alluvial Deposits

Stream channel deposits are Holocene in age and were deposited between 11,000 years ago and present day. The stream channel deposits occur along the current and ancestral paths of streams and rivers in Sutter County. Where present, the stream channel deposits extend from ground surface up to a depth of 80 feet below ground surface (Helley and Harwood 1985). The stream channel deposits consist of unconsolidated gravels, sand, silt, and clay, derived from the erosion and reworking of the Modesto and Riverbank Formations (described below). This unit is moderately to highly permeable, but because of its shallow depth and limited thickness, it possesses limited water-bearing capacity.

Basin deposits are Holocene in age and, like the stream channel deposits, were deposited between 11,000 years ago and present day. Basin deposits occur where sediment-laden floodwaters breached natural stream and river levees and spread across lower-lying topography. Where present, the basin deposits extend from ground surface up to a depth of 150 feet. The basin deposits consist mainly of silt and clay. These units have low permeability and generally yield small quantities of water to wells.

The Modesto Formation

The Modesto Formation is Pleistocene in age and is a stream terrace deposit that was deposited between 12,000 to 50,000 years ago (Helley and Harwood, 1985). Within this subbasin, the Modesto Formation consists of poorly indurated gravel and cobbles, sand, and clay and is derived from the reworking and deposition of the Riverbank Formation, Laguna Formation, and Tuscan Formation (DWR 2004). The Modesto Formation was likely deposited by the same stream and river systems that flow today, because it generally borders existing channels (Blake et. al. 1999). This formation may extend across the entire subbasin and where present, may range in thicknesses from 50 to 150 feet (DWR 2000). The sediments of the Modesto Formation are moderately to highly permeable and can yield moderate quantities of water to wells.

The Riverbank Formation

The Riverbank Formation is Pleistocene in age and was deposited between 120,000 and 500,000 years ago (Helley and Harwood, 1985). The Riverbank Formation consists of gravel and small cobbles, and is interbedded with reddish-clay, sand and silt. Like the Modesto Formation, the Riverbank Formation is a stream terrace deposit. However, the Riverbank Formation is older than the Modesto Formation. The

Riverbank Formation may extend across the entire subbasin, underlying the Modesto Formation, with thicknesses ranging from 50 to 200 feet. The Riverbank Formation is poorly to highly permeable and can yield moderate quantities of water to wells.

Sutter Buttes Rampart

The Sutter Buttes Rampart was deposited during the Middle to Lower Pleistocene period and is encountered in the southern portion of the subbasin. This unit is up to 600 feet thick in the subsurface (DWR 2000). In several studies (William and Curtis 1977, Springhorn 2008) the Sutter Buttes Rampart has been separated into two distinct units: the Rhyolitic Rampart and the Andesitic Rampart. The Andesitic Rampart phase of volcanism was much larger than the Rhyolitic phase. All the large peaks of the Sutter Buttes are andesitic domes and comprise the majority of the Rampart on the surface and the subsurface. The Sutter Buttes Rampart consists largely of gravel, sand, silt, and clay sediments which were deposited circumferentially around the Buttes as a geologic apron. These sediments may extend up to 15 miles north of the Sutter Buttes and west beyond the Sacramento River. Certain zones within these units yield large quantities of water (DWR 2004).

Laguna Formation

The Laguna Formation is Plio-Pleistocene in age and was deposited between 4 million and 2 million years ago. The Laguna Formation is comprised of Sierra Nevada sourced sediments, consisting of consolidated alluvial gravel, sand, and silt, comprised of granitic, metamorphic, and volcanic material. Estimates of the thickness of the Laguna Formation range from 180 feet (Helley and Harwood 1985) to 1,000 feet (Olmstead and Davis 1961). The Laguna Formation is characterized as being moderately consolidated and poorly to moderately cemented. Because of this, the permeability of formation is generally low to moderate. Wells completed in this formation have been observed to yield only moderate quantities of water (DWR 2003).

Tuscan Formation

The Tuscan Formation has been the subject of much interest in recent years. The Tuscan Formation is a regional aquifer system wholly or in parts of Tehama, Butte, Glenn, Colusa, and Sutter County. Within Sutter County, there has been limited analysis done on the subsurface extent of the Tuscan Formation. It is likely that the Tuscan Formation is only present in the northern portion of the County and consequently is not a major water resource for the County.

The Tuscan Formation is Plio-Pleistocene in age and was deposited between 4 million and 2 million years ago. The Tuscan Formation was derived by alluvial deposition associated with the erosion of volcanic material derived from Cascade volcanism. The formation outcrops from Red Bluff, in the northern part of the Sacramento Valley, to Oroville, southeast of Chico, and has been recognized in the subsurface at a distance of about 15 miles west of the Sacramento River (DWR 2003a). The deposits of the Tuscan Formation thin from east to west, from about 1,600 feet thick in the foothills of the Sierra Nevada to about 300 feet thick in the subsurface of the Sacramento Valley (Lydon 1969). In surface outcrops, the exposures of the Tuscan Formation are described as four separate, but lithologically similar units: Units A through D (Helley and Harwood 1985). Units A, B, and C are found within the subsurface in the northern part of the subbasin and units A and B are found in the southern part of the subbasin (DWR 2004). All of the units of the Tuscan Formation contain stratigraphic sequences of volcanic mudflows, volcanic conglomerates, volcanic sandstones, siltstones, and tuff deposits. In the subsurface, the Tuscan Formation consists largely of black volcanic sand and gravel, with interbedded layers of tuff breccias and tuffaceous clays (Ferriz, H. 2001). Unit A is the oldest (deepest) water-bearing unit and is distinguished from Units B and C by the presence of metamorphic clasts. Unit B contains equal distributions of volcanic mudflows, conglomerates, and tuffaceous sandstones. Units A and B are referred to as the “Lower Tuscan Formation”. Unit C is capped by massive volcanic mudflows with some interbedded conglomerates and sandstones. In the subsurface, the volcanic mudflows of Unit C act as a confining layer to groundwater flow, separating the more permeable deposits of the Lower Tuscan Formation (Helley and Harwood 1985).

4.2.4.2. Sutter Subbasin (Basin Number 5-21.62)

The Sutter Subbasin underlies the central portion of Sutter County and is wholly within the boundaries of the County. The subbasin is bound by the confluence of Butte Creek with the Sacramento River and the Sutter Buttes to the north, by the Feather River to the east, by the confluence of the Sutter Bypass and Sacramento River to the south, and by the Sacramento River to the west. The Sutter Subbasin aquifer system consists of late Tertiary to Quaternary aged deposits comprised of Sierra-sourced (Sierra Nevada) detritus and volcanic and clastic rocks in the northern portion of the subbasin around the Sutter Buttes. The identified geologic formations that comprise the Sutter Subbasin are (from youngest to oldest):

- Recent Alluvial Deposits;
- the Pleistocene aged Sutter Buttes Rampart and Victor Formation;
- the Pliocene Laguna Formation; and
- the informally named Sutter Formation.

Recent Alluvial Deposits

The Holocene aged stream channel and flood plain deposits occur along the current and ancestral paths of streams and rivers in Sutter County. The stream channel and flood plain deposits consist of unconsolidated gravel, sand, silt, and clay. Both thickness and grain size decrease as the distance increases from their source. Where present, the stream channel and flood plain deposits extend from ground surface to an estimated depth of 100 feet (Helley and Harwood 1985). These units are highly permeable and provide for large amounts of groundwater recharge within the subbasin. This unit is highly permeable, and yields significant quantities of water to wells (DWR 2000).

Sutter Buttes Rampart

The Sutter Buttes Rampart is Middle to Lower Pleistocene aged alluvial deposit that is encountered in the northern portion of the subbasin. This unit can be up to 600 feet thick in the subsurface (DWR 2000). In several studies (William and Curtis 1977, Springhorn 2008), the Sutter Buttes Rampart has been separated into two distinct units: The Sutter Buttes Rhyolitic Rampart and the Sutter Buttes Andesitic Rampart. The deposition and composition of Rhyolitic Rampart reflects the initial stages of volcanism and deposition around the Sutter Buttes, while the Andesitic Rampart reflects the later stages. These fan deposits form an apron around the Buttes and consist largely of gravel, sand, silt, and clay, and may extend up to 15 miles north of the Sutter Buttes and west beyond the Sacramento River. Certain zones within these units yield large quantities of water (DWR 2004).

Victor Formation

The Pleistocene aged Victor Formation is comprised of alluvial fan deposits composed of Sierra-sourced loosely consolidated gravel, sand, and silt. The Victor Formation has an estimated thickness of 100 feet (DWR 2004). This unit is observed to have an impermeable surface due to the presence of hardpan and clay pan soils (DWR 2003). At its base, the Victor Formation has been observed to have moderate

permeability and provides most of the groundwater for domestic and shallow irrigation wells in Sutter County (DWR 2003). Wells completed in this unit have been reported to have yields as high as 1,000 gpm.

Laguna Formation

The Laguna Formation is comprised of Sierra sourced, consolidated alluvial gravel, sand, and silt, which consist of granitic, metamorphic, and volcanic material. Estimates of the formations thickness range from 180 feet (Helley and Harwood 1985) to 1,000 feet (Olmstead and Davis 1961). The Laguna Formation is characterized as being moderately consolidated and being poorly-to-moderately cemented, because of this, the formation generally has a low to moderate permeability. Wells completed in this formation have been observed to yield only moderate quantities of water (DWR 2003).

Sutter Formation

The Mio-Pliocene aged Sutter Formation is an informally named stratigraphic unit that underlies the area around the Sutter Buttes and the central portion of Sutter County. The extent of the deposits have been characterized on a local to sub-regional scale and have been generally classified as volcanic and epiclastic[3] sediments derived from volcanic sources located to the east in the Sierra Nevada, western Nevada, and the southern Cascade Volcanic Province (Springhorn 2008). Due to the complexity of identifying distinguishable characteristics within these deposits, informal and formal stratigraphic units within this region have been grouped together. Some of the major regional stratigraphic units that have been included in the Sutter Formation (from youngest to oldest) are the Tuscan, Mehrten, and Princeton Valley fill deposits.

4.2.4.3. North American Subbasin (Basin Number 5-21.65)

A portion of the North American Subbasin underlies the southeastern section of Sutter County. The North American subbasin is bound by the Bear River to the north, the Feather River to the west, the Sacramento River to the south, and in the east by a north-south trending line that represents the approximate edge of the alluvial basin (DWR 2004). The North American Subbasin is dominated by late Tertiary to Quaternary aged deposits consisting of Sierra-sourced volcanic sediments and alluvial derived sediments. The identified geologic formations that comprise the North American Subbasin are (from youngest to oldest):

[3] Consisting of fragments of preexisting rocks

- Recent Alluvial Deposits;
- Older alluvial deposits (the Pleistocene aged Modesto, Riverbank, Victor, and Laguna Formations); and
- the Mio-Pliocene aged Mehrten Formation.

Recent Alluvial Deposits

Stream channel deposits are Holocene in age and were deposited between 11,000 years ago and present day. The stream channel deposits occur along the current and ancestral paths of streams and rivers in Sutter County. The stream channel deposits consist of unconsolidated gravels, sand, silt, and clay, derived from active stream deposition, overbank sedimentation, and the erosion and deposition of existing Quaternary stream terrace deposits such as the Modesto and Riverbank Formations. Where present, the stream channel deposits extend from ground surface to a depth of 100 feet (Helley and Harwood 1985). This unit is highly permeable, and yields significant quantities of water to wells (DWR 2000).

The flood plain deposits consist primarily of silt and clay size sediments, with intermittent lenses of stream channel deposits. These deposits are generally observed along the flanks of existing and ancestral stream and river systems. These deposits have an estimated thickness up to 100 feet. Being that this unit is primarily comprised of finer-grained material, permeability is generally poor and generally yields low quantities of water. Brackish water is commonly encountered within this unit (DWR 2000).

Older Alluvial Deposits

Within this subbasin, a number of geologic formations have been assigned to the category “older alluvium” including: the Modesto, Riverbank, Victor, and Laguna Formations (DWR 2004). These deposits generally underlie the Recent Alluvial Deposits and consist of loosely to moderately compacted gravel, sand, silt, and clay size sediments that were derived and deposited under alluvial conditions. The thickness of these units ranges from approximately 100 to 650 feet (DWR 2004).

Mehrten Formation

The Mehrten Formation is Mio-Pliocene in age and consists of a sequence of volcaniclastic and volcanic rocks. In the subsurface, the Mehrten Formation ranges in thickness from 200 feet to 1,000 feet along the axis of the Sacramento Valley (DWR

2003). The Mehrten Formation is comprised of two distinct geologic units. The first unit consists of sediments deposited under alluvial and fluvial conditions and are comprised of gravel, sand, silt, and clay size sediments. This unit is highly permeable and wells constructed within this unit have been observed to produce yields exceeding 1,000 gpm (DWR 2003). The second unit consists of dense volcanic flows of tuff breccias with some interbedded conglomerates and sandstones. This unit acts as a confining layer between sand intervals and has a thickness that ranges from 200 to 1,200 feet in the subsurface (DWR 2003).

4.2.5. Areas Outside a Designated Groundwater Basin

The only part of the County that is not within a designated groundwater basin is the area consisting of the Sutter Buttes. Groundwater is likely found in the subsurface in fractures of the volcanic rock; however, historic groundwater levels and water quality were not reviewed in the preparation of this GMP. There are no local entities, aside from private domestic water users, that utilize groundwater resources in this area.

4.3. Groundwater Levels

DWR does not currently consider any of the groundwater subbasins underlying the County to be in overdraft. Overdraft is characterized by a declining trend in groundwater levels over multiple years without recovery during recharge events. Historic groundwater level data were reviewed for each of the subbasins within the County. DWR maintains a publicly available on-line database, which includes groundwater level data for the County. The DWR Water Data Library (WDL) website can be found at http://www.wdl.water.ca.gov. Wells monitored by DWR and cooperating agencies are identified by the State Well Number (SWN). Data can be obtained for specific wells by means of a map interface, by groundwater basin, or by the assigned SWN.

A 79-year period of record for water level measurements in Sutter County depicts a groundwater system that has experienced changing conditions over time. A number of DWR monitored wells were selected throughout the County to represent these changes. The locations of these wells, along with their associated hydrographs illustrating the historic groundwater levels, are shown in Figure 9. Groundwater level data from well 10N/4E-12A1, a 290-foot-deep well located in the southeast portion of Sutter County, and well 13N/3E-32N1, a shallow (less than 100 feet deep) well located in the southern portion of the County show the groundwater levels typical of different areas of the County. Groundwater levels in well 10N/4E-12A1 are characteristic of areas of high groundwater use and differing water conditions. Water levels fluctuate, sometimes dramatically, in response to changes in groundwater use and hydrologic conditions. This well is located in an area where agricultural

demands are supplied entirely with groundwater. The Sacramento County Department of Water Resources website includes published groundwater elevation maps and indicates that this well is in close proximity to a large pumping depression in northern Sacramento County. Groundwater levels in well 13N/3E-32N1 are characteristic of areas with lower groundwater use and more stable water conditions, and as such, water levels have not exhibited significant fluctuations over times. This well is located in an area where agricultural demands have been met almost entirely with surface water and groundwater demands have consequently been small.

Groundwater levels in well 10N/4E-12A1 have varied from 20 to 80 feet below ground surface over time. The combination of high groundwater use, the close proximity to a pumping depression, and changing climatic conditions has led to significant declines in groundwater levels from the early 1950' through the late 1970's. In the middle to late 1970's, drought conditions increased the rate of decline of groundwater levels on an even larger scale. In the mid 1980's and early 1990's, private and municipal water agencies in a collaborative effort started to implement conjunctive water use programs. With the availability of surface water, and the decrease in groundwater pumpage, groundwater levels have been steadily recovering from the early 1980's through present. Groundwater levels in this well are currently about 35 to 40 feet higher than they were in the late 1970's.

Groundwater measurements in well 13N/3E-32N1 shows very stable groundwater levels since measurements began in 1942. Groundwater levels have remained virtually unchanged, with water levels within 5 to 6 feet of ground surface and seasonal fluctuations of less than 10 feet.

The direction of groundwater flow during the fall season within the County has not changed significantly from 1912-1913 (Bryan 1923) to 2007; with the exception of the southeastern portion of the County. Contours of equal groundwater levels from fall 1912-1913 and fall 2007 were compared to identify changes over the 95 year period. Figure 10 depicts changes in groundwater levels over the aforementioned period. In most areas within the County, groundwater levels were not dramatically different in 2007 than they were in 1912-1913. In the central portion of the County, an increase in groundwater levels is observed in the data, which may be likely due to applied surface water for irrigation. In the southeastern portion of the County, a significant decline in groundwater levels is observed, which can be related to the high usage of ground water for irrigation of crops, and the influence of the large pumping depression in the northern portion of Sacramento County.

Fall and spring contour maps of equal groundwater elevation for 2007, 2008, 2009, and spring 2010 were reviewed (Figures 11 through 17) to determine groundwater gradient and

flow direction. The fall 2009 and spring 2009 groundwater contours generally follow the topography of the County and indicate that groundwater flows from the Sierra Nevada toward the Sacramento Valley (east to west), and north to south within the Valley. The fall 2007 contour map of equal groundwater elevations indicates a few locations where small pumping depressions are present, but in general, suggests the same direction of groundwater flow as seen in the spring 2007 groundwater contour map. Differences in groundwater levels between fall and spring appear to be a result of normal fluctuations in groundwater conditions from seasonal pumping and from wet and dry climatic cycles.

Data from the nested monitoring well at the extensometer site in the southern portion of the County indicates that, for the 14 years of available data, the spring groundwater levels in the monitored aquifer zones have been very similar, within a few feet of one another; except for the deepest completion where groundwater levels are approximately 10 feet lower than the shallower completions.

4.4. Groundwater Quality

The quality of groundwater is a product of the material through which it flows, or that flows into it. Local variations in the quality of the County's groundwater can limit its use for either potable water supply and/or agricultural applications. Groundwater contamination is a result of naturally occurring, point source contamination, and/or regional contamination. Naturally occurring contaminants of concern include dissolved salts [as measured by the specific conductance or electrical conductance (EC)], boron, nitrate, manganese, arsenic, and mercury. Point source contamination typically involves solvent releases originating mostly from gas stations and dry cleaners. Regional sources of contamination include applied fertilizers, salts, and leaky septic systems (nitrate and salt loading).

Historic and current water quality data (collected by the DWR, USGS, and local water purveyors) for wells located within the County were analyzed to characterize spatial and depth dependent water quality trends within the County's groundwater subbasins. The data was separated by well depth into the following three categories: less than 150 feet deep, 150 to 400 feet deep and more than 400 feet deep, as shown in Figures 18 through 23. The categories were chosen based on the occurrence at which certain stratigraphic units are observed in the subsurface in Sutter County.

4.4.1. Specific Conductance

Specific conductance was selected as an indicator of overall water quality. Specific conductance is a property of groundwater that is relatively simple to collect in the field at the well head and can help identify and characterize the condition of the non-marine fresh water

bearing aquifer system. Specific conductance is a measure of how effectively water will conduct electricity and is reported in micro Siemens (µS/cm) per centimeter and provides for the indirect measurement of the amount of dissolved solids (salts) in the groundwater. Lower specific conductance generally indicates better water quality (fresh water) while higher specific conductance generally indicates poorer water quality (brackish to saline water).

Applied irrigation and fertilizers can add salts to the water that percolate into the hydrogeologic system, increasing the specific conductance of the groundwater. Increased specific conductance values of the groundwater can also be attributed to naturally occurring brackish or saline water, such as geologic formations (aquifers) which are, or have been in the past, directly connected to a salt water body or where geologic formations were deposited under marine (salt water) conditions and which have inherently high dissolved salt concentrations. As shown in Figures 18 and 19, specific conductance values within the County are generally acceptable for agricultural and domestic use east of Highway 99 and in the northern half of the County. Elevated values for specific conductance are near to and/or exceed the recommended maximum contaminant level (MCL)[4] for domestic use in the shallow aquifers near the Sacramento River and in the aquifers below 900 feet. The elevated specific conductance could potentially be problematic for agricultural use. It is unclear why there is elevated specific conductance in this area.

4.4.2. Boron

Boron is a naturally occurring element. As shown in Figure 20, boron concentrations in the County are generally acceptable. Some deeper wells, which likely encounter more marine sediments, do contain elevated boron concentrations. Boron is a necessary element for agriculture, but may become toxic to crops above 500 micrograms per liter (µg/L). For public drinking water systems, the California Department of Public Health (CDPH) has established a notification level of 1,000 µg/L for boron. Increased concentrations of boron are observed in wells greater than 400 feet as well as in the southwestern portion of the County.

4.4.3. Nitrate

Nitrate is a contaminant which does not naturally occur in the subsurface. Elevated concentrations of nitrate are widespread in the Sacramento Valley. As shown in Figure 21, concentrations of nitrate in the populated areas of Sutter County are near or above the MCL for nitrate (as NO_3). The CDPH has established a primary MCL of 45 milligrams per liter (mg/L) for nitrate (as NO_3). Near the Sutter Buttes and Yuba City, nitrate concentrations in several wells (less than 150 feet) exceed the MCL. Where present, elevated concentrations of

[4] Recommended CDPH MCL for Specific Conductance is 900 µS/cm; upper limit is 1,600 µS/cm; short term is 2,200 µS/cm

nitrate are likely a result of overlying land uses, such as septic systems, animal enclosures, or applied fertilizers.

4.4.4. Manganese

Manganese is a naturally occurring element found in rocks and minerals. Its presence in groundwater is a result of the dissolution of the naturally occurring element in sediments containing minerals composed of manganese. As illustrated in Figure 22, manganese concentrations are elevated in all portions of the County, at levels that may cause aesthetic problems (odor or staining) for domestic and municipal uses, but generally below levels that could represent a health risk. There are, however, a few locations where manganese concentrations are near or exceed the CDPH established Notification Level of 50 µg/L, and may pose a health risk.

4.4.5. Arsenic

Arsenic is a naturally occurring element commonly found in alluvial sediments. Its presence in groundwater is a result of the dissolution of the element in sediments containing minerals containing arsenic. The CDPH has established a primary MCL of 10 µg/L for arsenic. As illustrated in Figures 19 and 23, arsenic concentrations are near to or above the CDPH MCL throughout the County in each of the aquifer zones assessed; conversely, concentrations of arsenic below the CDPH MCL are also present throughout the County in each of the aquifer zones assessed. Countywide, arsenic concentrations do not appear to be isolated to any one specific aquifer zone in the subsurface. However, recent data analysis suggests a possible correlation between elevated arsenic concentrations and the presence of volcaniclastic material of the Sutter Buttes Rampart formation. Concentrations of arsenic in the stratigraphic units that occur above and below the Rampart are generally less than 10 µg/L, whereas concentrations of arsenic within the Rampart material are between 10 to 370 µg/L (Springhorn, 2008). Concentrations of arsenic tend to be under the CDPH MCL southeast of Highway 99 and in the shallow aquifers.

4.4.6. Mercury

Historic gold mining processes and operations introduced toxic mercury into the surface water system throughout Northern California in the late 1800’s. Due to the proximity of these operations to Sutter County, the PAG requested an assessment of the concentrations of mercury in the groundwater. A limited number of wells have been sampled within Sutter County for mercury, and as such, concentrations of mercury in the groundwater within Sutter County can not be well characterized. The few wells that have been sampled for mercury

indicate that mercury concentrations were low. In most cases, the concentrations were below the analytical detection limit (not detectable by the laboratory method used at the time).

4.5. Land Subsidence

Land subsidence is the gradual or sudden lowering of the land surface due to compaction of the underlying sediments. Two types of land subsidence are observed within alluvial sediments: inelastic and elastic. Inelastic land subsidence is a result of the compression of geologic formations and is irreversible. Inelastic land subsidence can be caused by excessive extractions of groundwater, oil, or natural gas. In discussing land subsidence, it is important to note that elastic (reversible) land subsidence is a normal occurrence, whereas inelastic land subsidence has associated negative impacts.

Although there are several causes of inelastic land subsidence, the compression of clay as a result of groundwater extraction is considered the most likely cause of subsidence north of the Sacramento-San Joaquin Delta (Page 1998). Once water is removed (mined) from compressible clay, the clay compresses and cannot accept water again, thus resulting in the permanent lowering of the overlying land surface (inelastic land subsidence). Clay compression has occurred in several locations in California, including the San Joaquin Valley. Compressible clay, such as the Corcoran Clay member of the Tulare Lake Formation, has been mapped over much of the western side of the San Joaquin Valley and can be over 130 feet thick. The subsidence documented in the San Joaquin Valley extends over a very large area, with over 30 feet of subsidence recorded in some areas.

North of the Sacramento-San Joaquin Delta in the Sacramento Valley, inelastic land subsidence, which has been directly related to clay compression as a result of groundwater extraction, has occurred in portions of Solano, Yolo, and Colusa Counties (Page 1998). Recorded land subsidence of more than two feet, and possibly as much as five feet, has occurred in this area. Subsidence in the Sacramento Valley appears to extend from Davis to Arbuckle. The area of subsidence appears to follow a local geologic feature known as the Zamora Syncline. A syncline is a structural fold that is formed by compressional forces which cause the sedimentary layers to have a concave, or a bowl-like geometry. Lakebeds are often associated with structural lows such as synclines. Lakebed deposits typically consist of fine-grained, clayey sediments, which settle out to the bottom of standing bodies of water and of which can include large volumes of freshwater diatoms[5]. Along with sediments, the microscopic diatoms settle and collect on the bottom of a lakebed. In Yolo County, diatomaceous (diatom rich) clay sediments have been identified within the geologic formations of Zamora Syncline. These diatomaceous clay sediments were identified to be

[5] Diatoms are unicellular aquatic algae, typically 20 to 200 microns (Prothero, 1998)

highly compressible (Page 1998). Although diatomaceous clay has been identified in numerous boreholes drilled in Sutter County, there have not been any recorded land subsidence issues.

Elastic land subsidence is observed to be cyclical and does not result in permanent compaction of subsurface materials. One example of elastic land subsidence is seasonal fluctuations in ground surface elevations that coincide with fluctuations in groundwater levels (and associated aquifer pressure). In elastic land subsidence, the subsurface pressures acting on the aquifer do not decrease enough so that subsurface materials permanently compact.

The DWR, in cooperation with federal, state and local agencies, installed and surveyed Global Positioning System (GPS) monuments to be able to measure and monitor ground surface elevations over time in the Sacramento Valley. The project, titled "The Sacramento Height-Modernization Project", consists of 339 monuments, spaced approximately 7 kilometers apart, in 10 counties. There are 32 monuments located in Sutter County. The GPS monuments will augment the existing network of extensometers which DWR currently monitors for land subsidence. In total, there are 13 extensometers located in Glenn, Colusa, Butte, Yolo, and Sutter Counties. The land subsidence monitoring network is shown in Figure 24. Only one of these extensometers, State Well Number 11N/4E-04, is located within Sutter County. It is located in the south-central part of the County along Highway 99, and extends to a depth of 1,003 feet, extending over a large portion of the fresh-water formations. The extensometer is installed in a dedicated monitoring well and is designed to measure any change in distance between the bottom of the well and the ground surface. DWR reports the accuracy of the extensometer to be ±0.001 feet. The extensometer provides for ongoing, real-time data collection, of land surface elevation changes. The Sutter County extensometer has been recording data since early 1994. In the 14 years since it began recording, the extensometer in Sutter County has recorded seasonal (cyclic) elastic land subsidence of approximately 0.03 feet (approximately one-third inch). There has been no indication over the period of record that any inelastic subsidence has occurred.

4.6. Groundwater-Surface Water Interaction

Several clustered monitoring wells located throughout the county adjacent are used to monitor changes in surface flow or quality that directly affect the groundwater system (levels or quality), and/or to monitor changes in surface flow or quality that are caused by groundwater pumping. These monitoring wells are adjacent to surface water bodies, and have a river stage gage located in the immediate vicinity.

Several of the network wells are located along the banks of the Sacramento, Feather, and Bear Rivers, as shown in Figure 25. The relationship between the volume of water flowing in the major rivers/streams and the influence the surface water imparts on groundwater elevation are being monitored with a combination of nested monitoring wells and river stage gages. Four stations exist in the County for observing this interaction: on the Sacramento River below Wilkins Slough (WLK), on the Bear River at Pleasant Grove Road (BPG), on the Sutter Bypass at RD 1500 pump (SBP), and along the Feather River above Star Bend (FSB). Sutter County also monitors a river stage gage at Boyd's Landing (FBL). At stations BPG and FBL, observations of water surface/groundwater elevations trend closely during high flow/stage events in the rivers, suggesting a significant hydrologic connection between the groundwater in the shallow aquifers and the surface water.

4.7. Groundwater Recharge

Groundwater recharge is the process in which groundwater is replenished. The geologic formations that comprise the aquifer system underlying the County extend well beyond the County's jurisdictional boundaries. Several processes are responsible for recharge of the groundwater basin. On a regional scale, surface water flowing over the surface expression of the geologic formations (surface outcrops) allows for direct infiltration into the hydrogeologic system. Figure 26 depicts contours of equal groundwater elevations, superimposed over the surface geology, for the Sacramento Valley Groundwater Basin. Groundwater flow is perpendicular and down gradient to the contour interval. On the east side of the Sacramento Valley Groundwater Basin, the groundwater contours become parallel to and follow the margin of the valley, indicating groundwater is moving through the subsurface from the east to the west. Locally, groundwater recharge occurs where surface water flows over permeable sediments (gravel and sand) in the river channels, allowing for the direct infiltration of surface water. Deep percolation of applied irrigation water also recharges the groundwater basin. Additionally, surface water deliveries have increased the quantity of water flowing down the river, adding available water to recharge the underlying aquifers helping to improve groundwater elevations.

The amount of groundwater recharge is dependent on the available storage space within the aquifer(s). Depending on the degree of separation between the elevation of the bottom of the river or stream and that of the groundwater, streams can either "lose" water into the underlying aquifer(s) or "gain" water. Where groundwater levels are at or above the elevation of surface water, groundwater will discharge into the stream (gaining stream). Where there is a separation between the groundwater and surface water, water flowing downstream will recharge into (losing stream) the groundwater basin (although the contribution has not been

studied). Conversely, if groundwater levels are at land surface, there will be refusal of any "new" water into the subsurface.

The State Water Resources Control Board has identified hydrogeological vulnerable areas, meaning vulnerable to groundwater contamination, where geologic conditions allow recharge to the underlying aquifers. Generally, these areas include the coarse deposits associated with the Feather River.

4.8. Groundwater Infrastructure

According to DWR records, 6,742 well completion reports have been filed for wells constructed in Sutter County. Well completion reports are not always filed with DWR, even though they are required by law, so the number of reports likely under-represent the actual total for the County. Of the wells for which well completion reports have been filed:

- 3,344 are domestic wells
- 1,167 are irrigation wells
- 854 have unknown or other uses
- 308 are monitoring wells
- 75 are municipal wells
- 34 are industrial wells
- 13 are test wells
- Seven (7) are stock-watering wells
- 12 are fire or frost protection wells
- Two (2) are cathodic protection wells

Figure 27 shows the number of DWR well completion reports filed for Sutter County from 1928 through 2007. The figure only illustrates wells that were classified as either: domestic, irrigation, or public supply. Domestic wells were constructed at a rate of approximately five per year from 1941 through 1950, but have been constructed at a rate of approximately 59 per year since then. Irrigation wells tend to be constructed more frequently during drought periods, in the mid-1970's and early 1990's. On average, 16 irrigation wells are constructed per year; however, significantly more wells are constructed during droughts. Municipal well construction has averaged two-and-a-half per year. Of the wells for which records exist, approximately 700 wells are classified as either abandoned or destroyed.

Figure 28 shows the average depth of wells constructed from 1950 through 2005. The average depth of domestic wells has fluctuated since the 1930's, but has generally been about 100 feet deep. The average depth of irrigation wells has fluctuated significantly, but has been about 160 feet deeper than the average depth of domestic wells in any give year, or an average of about 260 feet deep. Municipal well depths are inconsistent and vary widely in

depth, from about 50 to 700 feet deep. Combined with the small number constructed annually, calculation of an average depth of new municipal wells would not be meaningful.

5. GROUNDWATER MANAGEMENT PLAN REQUIRED, VOLUNTARY, AND RECOMMENDED COMPONENTS

California Water Code §10750 et seq., as amended by Senate Bill (SB) 1938, defines the required and voluntary components of a GMP and establishes procedures by which they must be developed. DWR recommends additional elements to include in a GMP in Bulletin 118 Update 2003, Appendix C. The Sutter County GMP includes the components required in the Water Code and has been developed in accordance with the required procedures. This GMP also includes many of the voluntary and recommended GMP components. This GMP also includes components designed to address the requirements of California Water Code §10920 et seq., which establish requirements for groundwater monitoring that affect eligibility for grant funding.

5.1. California Water Code Requirements

Section 10750 et seq. of the California Water Code, as amended by SB 1938, requires GMPs to include six mandatory components to be eligible for the award of funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These components are listed below.

Description	***GMP Section***
Make available to the public a written statement describing the manner in which interested parties would be allowed to participate in the development of the GMP.	1.4
Include Basin Management Objectives (BMOs), including components relating to the monitoring and management of groundwater levels, groundwater quality degradation, inelastic land subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping.	6.2
Prepare a plan that involves other agencies that enables Sutter County to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin.	7.1.5
Prepare a map that details the area of the groundwater basins, Sutter County's boundaries, and other local agencies within the groundwater basins.	Figure 1

Description	*GMP Section*
Adopt monitoring protocols to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence, and flow and quality of surface water that directly affects groundwater levels or quality or are caused by groundwater pumping.	7.1
For areas outside the groundwater basins, use geologic and hydrologic principles appropriate to those areas.	4.2.5;7.1.4

5.2. DWR Bulletin 118 Recommended Components

DWR's Bulletin 118 recommends other components that may voluntarily be included in a GMP. These are listed below.

Description	*GMP Section*
Establish an advisory committee of stakeholders to help guide the development and implementation of the plan and provide a forum for resolution of controversial issues.	1.4
Describe the area to be managed under the GMP.	1.3
Describe how meeting each BMO will contribute to a more reliable long-term groundwater supply, and describe management actions to achieve each BMO.	6.2
Describe GMP monitoring program.	7.1
Describe integrated water management planning efforts.	7.1.5
Periodically report groundwater basin conditions and management activities.	7.1.6
Evaluate GMP periodically.	7.1.6

5.3. California Water Code Voluntary Requirements

California Water Code §10753.8 lists twelve issues of groundwater management which may voluntarily be included in a groundwater management plan.

Description	*GMP Section*
Control of saline water intrusion.	6.1.3
Identification and management of wellhead protection areas and recharge areas.	4.7; 6.1.3
Regulation of the migration of contaminated groundwater.	N/A
Administration of well abandonment and well destruction program.	6.1.3
Mitigation of conditions of overdraft.	4.3
Replenishment of groundwater extracted by water producers.	N/A
Monitoring of groundwater levels and storage.	4.3; 5.4
Facilitating conjunctive use operations.	6.1.3
Identification of well construction policies.	6.1.3
The construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.	N/A
The development of relationships with state and federal regulatory agencies.	7.1.5
Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.	7.1.6

5.4. California Water Code Groundwater Monitoring Components

On November 4, 2009 the State Legislature amended the Water Code with Senate Bill SBx7-6, which mandates a statewide groundwater elevation monitoring program to track seasonal and long-term trends in groundwater elevations in California's groundwater basins. To achieve that goal, the amendment requires collaboration between local monitoring entities

and DWR to collect groundwater elevation data. Collection and evaluation of such data on a statewide scale is an important fundamental step toward improving management of California's groundwater resources.

In accordance with this amendment to the Water Code, DWR developed the California Statewide Groundwater Elevation Monitoring (CASGEM) program. The intent of the CASGEM program is to establish a permanent, locally-managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. The CASGEM program will rely and build on the many, established local long-term groundwater monitoring and management programs. DWR's role is to coordinate the CASGEM program, to work cooperatively with local entities, and to maintain the collected elevation data in a readily and widely available public database. DWR will also continue its current network of groundwater monitoring as funding allows.

The law anticipates that the monitoring of groundwater elevations required by the enacted legislation will be done by local entities. The law requires local entities to notify DWR in writing by January 1, 2011 if the local agency or party seeks to assume groundwater monitoring functions in accordance with the law (Water Code §10928).

Additionally, on or before January 1, 2012, the law requires that Monitoring Entities shall begin reporting seasonal groundwater elevation measurements to DWR (Water Code §10932).

Local entities in Sutter County that have submitted official notifications to DWR to be considered for CASGEM Monitoring Entities include:

- Sutter Extension Water District
- Feather Water District
- Reclamation District 1500 (including RD 1500, Pelger Mutual Water Company and Sutter Mutual Water Company)
- Natomas Central Mutual Water Company
- South Sutter Water District

Garden Highway Mutual Water Company has shown interest in participating in CASGEM but has not yet completed the official notification submittal process include.

Local entities that submit complete Monitoring Entity notifications and adequate groundwater monitoring plans and well networks will be officially designated by DWR to be

the Monitoring Entities for their respective subbasin or portion of a subbasin for the purposes of the CASGEM Program. However, if no local monitoring entity volunteers or is identified for a particular area or groundwater basin, DWR may assume the monitoring and reporting duties and certain entities in the basin may not be eligible for water grants or loans administered by the state.

Sutter County is severely limited in its ability to take a lead in groundwater monitoring because of budget and staff shortages. Furthermore, the County does not own any groundwater monitoring wells and does not conduct any groundwater monitoring on its own. For this reason, Sutter County does not seek to assume groundwater monitoring functions under California Water Code §10920 et seq. However, the County does promote the coordinated collection of groundwater elevation data through its Groundwater Monitoring Program, discussed in Section 7.1 of this GMP.

6. GROUNDWATER MANAGEMENT GOALS AND BASIN MANAGEMENT OBJECTIVES

6.1. Groundwater Management Goals

Sutter County's groundwater management goals represent the overarching intent of the County with regard to groundwater management. Basin Management Objectives (BMOs) and Management Actions must be consistent with these Groundwater Management Goals, and must contribute to achieving the goals. Sutter County's goals for groundwater management (as developed with input from the public through PAG meetings and workshops) are:

- To promote responsible groundwater use in Sutter County so groundwater is available to meet present and future demands.
- To provide groundwater users with information and guidance to help them be responsible stewards of the groundwater resources in Sutter County.
- To discourage activities that could reduce the long-term availability of high-quality groundwater in Sutter County.

Each of the Groundwater Management Goals is discussed below.

6.1.1. To Promote Responsible Groundwater Use in Sutter County So Groundwater is Available to Meet Present and Future Demands.

One of Sutter County's main goals for groundwater management is to ensure that a reliable water supply is available so that water users in the County can be confident that water will be available to meet domestic, irrigation, and other demands on an ongoing basis.

The goal to promote responsible groundwater use in Sutter County is intended to provide the County with useable groundwater resources now and in the future. This is important because the socio-economic well being of the County could be adversely affected if the groundwater supply becomes less useable from a supply or quality standpoint. Ensuring responsible groundwater use will help protect groundwater rights and maintain local control because adjudication of the groundwater basin will not be warranted if long-term groundwater sustainability can be achieved.

6.1.2. To Provide Groundwater Users with Information and Guidance to Help Them Be Responsible Stewards of the Groundwater Resources in Sutter County.

It is important to understand that in order to responsibly manage groundwater to ensure long-term groundwater sustainability, it is necessary to thoroughly understand the groundwater system underlying the County, along with its capabilities and limitations. Sutter County's water resources should be viewed as a dynamic system with the amount of available surface water and groundwater varying over time with fluctuations in hydrologic and climatic conditions. The implementation of a surface/groundwater monitoring program to observe and document the County's resources is essential to provide the community with the necessary information to accomplish this management objective.

6.1.3. To Discourage Activities that Could Reduce Long-Term Availability of High-Quality Groundwater in Sutter County.

It is important to recognize that this management objective is not intended to restrict the users within the community from exercising their legal rights to groundwater. Groundwater is a resource that should remain available for the people of the County to use beneficially on their property. The intent of this objective is for groundwater management to be accomplished in a way that minimizes activities that could potentially reduce the long-term availability of high-quality groundwater in Sutter County. There are a number of management practices that can be utilized to accomplish this goal. Two of the main practices that should be considered are conjunctive use programs and improving County well standards.

The goal of optimizing the conjunctive use of surface water and groundwater will enhance the County's water supply reliability and maximize the available water supply. The term "conjunctive use" basically means using surface water and groundwater together to meet water demands, using different proportions of each depending upon availability. For example, in years of reduced surface water availability, more groundwater would be used and groundwater levels might decline. Conversely, in years of full surface water availability, less groundwater would be used and groundwater levels would be allowed to recover. Optimizing conjunctive use generally means that, whenever possible, surface water is used to the fullest extent with groundwater serving as a "back-up" supply. This maximizes the available water supply because unused surface water generally flows downstream and is lost, but unused groundwater remains in the ground and would be available for later use.

On the other hand, the potential may exist in some areas of the County where groundwater levels are (and have historically been) high, to utilize more groundwater and thus induce more recharge (by creating additional storage space within the aquifer) thereby increasing the total water supply available in the County.

A related goal is to "even out" water availability in the County. There are cases when surplus water is available in some areas of the County, but other areas have inadequate supplies. For example, an area with high groundwater levels may have adequate or excess surface water, while another area may have low groundwater levels and inadequate surface water. In this case, groundwater could be pumped in the area with high groundwater levels, and their surface water could be transferred to the area with low groundwater levels so that area does not have to rely as much on groundwater. If possible, undertaking such projects will help improve the overall water supply reliability in the County.

The goal for updating the County's well standards is to add additional levels of protection to ensure that the design of new well structures prohibit the downward migration of surface/shallow contaminants or cross contamination of aquifers. The County has adopted standards as set forth in Chapter II of the State Department of Water Resources Bulletin 74-81, and as supplemented by Bulletin 74-90, entitled "Water Well Standards: State of California", except as otherwise provided in Section 700, Chapter 765 "Water Wells" of the Sutter County Municipal Code[6]. Some amendments that could be made to the existing well standards are: (1) require the use of geophysical surveys for all new well projects, (2) increase the required minimum sanitary seal depths, (3) institute water quality sampling during cable tool well drilling, (4) institute well restriction zones where poor water quality is known, and (5) improve/implement well destruction programs.

Requiring the use of geophysical surveys (spontaneous potential, 16- and 64-inch resistivity) in all new boreholes can help to enhance groundwater protection by identifying the zone(s) of poor water quality, as well as the depths of confining layers, which can be used to design adequate sanitary/annular seals. With this data, future wells can be designed to effectively seal against poor water quality while providing adequate measures for aquifer protection.

Increasing the minimum sanitary seal depth required for new wells is a proactive measure that can effectively increase aquifer protection. Increasing the required sanitary seal to a minimum depth of 50 feet for all new wells can seal off shallower aquifers with poorer water quality from the deeper aquifers with better water quality, as well as impede the

[6] http://www.co.sutter.ca.us/doc/government/bos/ordinance

downward migration of surface contaminants. Currently, the standards in force require a minimum 50-foot sanitary seal for municipal supply wells and 20-foot sanitary seal for all other wells (Bulletin 74-90).

Many wells in Sutter County have been drilled and constructed utilizing the cable tool drilling method. One of the main troubles with cable tool wells is that they usually are constructed across, and connect, multiple aquifer zones. Some of these well structures likely have become conduits for the downward migration and cross contamination of aquifer zones. Water quality sampling during the drilling of these wells (field tests for TDS or specific conductance) would delineate between problematic and non-problematic aquifer zones. If an existing well is deemed problematic (i.e. poor water quality), corrective measures through well modification or even well destruction could help mitigate the movement of poorer water quality between aquifer zones.

Implementing well restriction zones where water quality contamination is known to exist in specific aquifers can aide in protecting aquifers with acceptable water quality. Restricting the construction of wells or requiring specific seal intervals can provide an additional level of aquifer protection. Certain areas within Sutter County have localities of poorer water quality. It may be beneficial to assess the risk of drilling and constructing new wells within these areas. If adequate aquifer protection can not be achieved during construction activities, it may be warranted to designate well exclusion zones.

Unused, unsecured, abandoned, or improperly destroyed wells can act as a direct conduit for surface water infiltration or degradation of one or more aquifers, if they are connected by the well structure. Well destruction requirements adopted by the County currently require abandoned wells to be destroyed. Currently, these requirements require the uppermost 20 feet of the well/borehole be filled with impervious material. Special situations, in the case where vertical movement of poor water quality could contaminate an aquifer with good water quality, require impervious sealing material to be placed adjacent to confining layers. Increasing oversight of the permitting process during the planning and design of well destruction programs can ensure added protection against the vertical migration of poor water quality.

6.2. Basin Management Objectives

Basin Management Objectives (BMOs) are guidelines established to ensure that the County's basin management goals are being fulfilled. BMOs create a systematic method for collecting and monitoring data for specific components of the groundwater system and to provide for the dissemination of such information to the public. The objective of the BMOs is not to assign a fixed value, or level, to each parameter, but to allow for the early identification of

potential problems with sufficient time for the County and its groundwater users to formulate an action plan to mitigate adverse effects to its groundwater resource.

Sutter County's BMOs address the following parameters:

- Groundwater levels
- Groundwater quality
- Inelastic land subsidence
- Surface water
- Coordination

6.2.1. Groundwater Levels BMO

There are three BMOs for groundwater levels:

- *Avoid ongoing declines in groundwater levels during water year types identified by DWR to be "above normal" or "wet" for the Sacramento Valley.*
- *Avoid problematically high groundwater levels.*
- *Provide assistance with assessing problems and resolve disputes related to groundwater levels.*

Groundwater levels are to be managed to ensure adequate water supplies while avoiding adverse impacts and mitigating them if and when they do occur. Adverse impacts related to groundwater levels can occur from excessively high or low groundwater levels. What constitutes an excessively high or low groundwater level may change over time, and will also vary by land use and hydrologic and climatic conditions.

Excessively high groundwater levels are problematic in some areas of the County. High groundwater levels in Sutter County are often naturally occurring. However, groundwater levels can be raised by application of water to the ground surface through irrigation, surface storage, or recharge projects. When groundwater levels are high, there is no storage capacity available in the underlying aquifer for groundwater recharge from precipitation, stream flow, or excess applied irrigation water. This represents a lost opportunity to capture recharge and increase the overall water supply for the County. Adverse impacts related to high groundwater levels include:

- Damage to foundations, roads, and other infrastructure.

- Water-logging the root zone of certain crops.

Groundwater levels decline when pumping exceeds recharge and rise when recharge exceeds pumping. It is important to note that periodic short-term declines in groundwater levels (during drought periods and/or increased pumping), which are then followed by recovery to at or near historic highs (during wet periods and/or decreased pumping), are normal and do not represent overdraft. Excessively low groundwater levels that are caused by long-term declines without recovery, thus overdraft, can be avoided by reducing pumpage. This can be accomplished by expanding the conjunctive use with surface water. Adverse impacts related to low groundwater levels include:

- Infrastructure problems when lowered groundwater levels dewater pumps or wells, so groundwater cannot be extracted using existing infrastructure even though it is available at greater depths.
- Depleted available groundwater supply.
- Inelastic land subsidence.
- Riparian and/or native vegetation destroyed.
- Reduced surface water flow due to increases in streambed infiltration, or increases in the capture of groundwater that otherwise would have contributed to increasing the base flow of a surface water system.

6.2.2. Groundwater Quality BMO

The BMO for groundwater quality is to:

- *Improve the understanding of groundwater quality in Sutter County.*
- *Maintain or improve groundwater quality.*

Adverse impacts to groundwater quality most commonly occur when degradation of groundwater renders groundwater unsuitable for intended uses. Accordingly, what constitutes a significant adverse impact to groundwater quality is related to the purposes for which groundwater is used, and may change over time as land uses and water quality regulations change. Groundwater quality degradation can occur when groundwater pumping causes poor quality water (surface water or groundwater) to migrate into areas with good quality groundwater. It can also occur when surface contaminants migrate into groundwater. As a consequence, it is important to coordinate land use planning and

resource management activities in order not to create opportunities for water quality deterioration. Adverse impacts related to groundwater quality include:

- Degradation of groundwater quality so that yields are reduced for crops irrigated with groundwater.
- Degradation of groundwater quality so that it does not comply with drinking water quality standards.
- Degradation of groundwater quality so that it is no longer suitable for beneficial uses.

There are some areas in Sutter County that currently have problems with groundwater quality (particularly arsenic and salinity) that appear to be naturally-occurring. The BMO of maintaining or improving groundwater quality reflects the County's desire to improve the quality of naturally-occurring groundwater where possible, so that it is more useful as a water supply.

6.2.3. Inelastic Land Subsidence BMO

The BMO for inelastic land subsidence is to:

- *Avoid inelastic land subsidence that is linked to declines in groundwater levels.*

Inelastic land subsidence is the permanent compaction of the subsurface. In Sutter County, the activities that have the most potential to cause inelastic land subsidence are withdrawals of groundwater or natural gas from the subsurface. Adverse impacts related to inelastic land subsidence include:

- Reduction in the volume of the subsurface that results in a permanent loss in aquifer storage.
- Damage to foundations, roads, bridges, and/or other infrastructure.
- Change in surface topography that reverses the gradients in canals and ditches, and/or changes floodplains.

6.2.4. Surface Water

There are three BMOs for surface water:

- *To improve the understanding of the relationship between surface water and groundwater.*

- *To avoid changes in surface water flow and surface water quality that adversely affect groundwater levels or are caused by groundwater pumping.*
- *Avoid changes in surface water flow and water quality that adversely affect groundwater quality.*

Pumping from very shallow aquifer zones or poorly sealed wells has the potential to affect surface water or wetlands. Adverse impacts related to surface water or wetlands include:

- Depletion of surface flows and/or degradation of water quality.
- Destroying riparian and/or native vegetation and habitat.

6.2.5. Coordination

This BMO for coordination is to:

- *Coordinate County groundwater management efforts with other groundwater management efforts within and surrounding Sutter County.*

This BMO establishes the importance of local coordination of groundwater management and sharing of hydrogeologic data. To make effective and relevant decisions, the County must rely on current data regarding the quality and quantity of the underlying groundwater.

7. PLAN IMPLEMENTATION

Sutter County intends to implement this GMP through a Groundwater Monitoring Program and an Action Plan. In order to recognize and mitigate adverse impacts to the underlying groundwater system, a system is required to collect and disseminate information to the appropriate groundwater users and agencies.

7.1. Groundwater Monitoring Program

The role of monitoring is essential to implementing the BMOs. Monitoring is the process of collecting data that is used to better understand the groundwater basin underlying the County, evaluate groundwater conditions, facilitate groundwater management, and other related activities. In order for the County to promote sustainable groundwater management, as well as for groundwater users to make effective and relevant decisions, the data needs to be made publicly available.

7.1.1. Groundwater Level Monitoring

There is an extensive network of DWR monitored wells, both dedicated monitoring wells and wells with other uses, within Sutter County. Additionally, several water purveyors within the County monitor groundwater levels within their service areas by means of dedicated monitoring wells and production wells. There is an extensive inventory of wells with groundwater measurements within Sutter County. Historically, DWR and its partners have monitored 172 wells in Sutter County, including 15 dedicated monitoring wells. The earliest recorded DWR water level measurement in Sutter County took place in 1929. Wells accessible to DWR are typically agricultural or domestic wells in which the land owners have previous agreements with DWR to allow access for measurements. Overall, the County has adequate spatial distribution of its current network to obtain groundwater level measurements. For this GMP, DWR utilized 122 of the 172 wells to produce groundwater contour maps of equal elevation.

Water level measurements are generally made two times each year, in spring and fall. Measurements have been made at some monitoring wells on an almost-monthly basis. Twice-annual (spring/fall) water level measurements are generally sufficient for the purpose of determining changes in overall groundwater conditions over time. However, these measurements should reflect the annual high (spring) and low (fall) water levels. More frequent (i.e. at most monthly) measurements are necessary to confirm that the months chosen for spring and fall measurements reflect the months with the highest and lowest groundwater elevations, on average. Water level data is currently available from DWR's Water Data Library, at: http://well.water.ca.gov.

7.1.1.1. Vertical Groundwater Gradients – Nested and/or Clustered Monitoring Wells

The vertical gradients between aquifer zones are important because they give an indication of the direction (up or down) that groundwater will migrate if a pathway, such as a well that connects multiple aquifer zones, is present. To evaluate the vertical gradient between aquifer zones, data for the different aquifer zones at a single location is needed. The preferred way to obtain this data is with nested and/or clustered monitoring wells. Nested monitoring wells have multiple wells within a single borehole, with each well isolated from the others by annular seals. Clustered monitoring wells have a single well in each borehole, with the boreholes in close proximity to one another. Figure 19 shows the locations of the 15 nested and/or clustered monitoring wells in Sutter County. Eleven of these wells are in the DWR monitoring network with measurements taken twice a year, in spring and fall. The remaining four nested monitoring wells are pending inclusion into the network because they were constructed by private parties. All of these wells are dedicated monitoring wells.

7.1.1.2. Groundwater Flow Direction – Contour Maps

The direction of groundwater flow is evaluated with groundwater level contour maps. Groundwater contours are created which connect surfaces of equal elevation (or levels). Figure 17 illustrates the contours of equal groundwater elevation for measurements taken in the spring of 2010.

The current water level monitoring network spacing is suitable for contouring groundwater elevations. Additionally, it would be beneficial to include data from nearby monitored wells in Butte, Yolo, Sacramento, and Yuba Counties to better characterize the groundwater flow direction at the County lines.

7.1.2. Water Quality

Water quality samples from wells within the County have, in the past, been obtained either by local water purveyors, the DWR, or the USGS. Currently, the County only samples groundwater in Robbins, its only public water supply system. Groundwater samples have been collected for analysis in a total of 133 wells. The DWR has sampled 34 of these wells in Sutter County, fifteen of which are nested multiple-completion monitoring wells, as shown in Figure 19. The USGS has sampled 94 of these wells, and the remaining wells were sampled by water purveyors which have shared their data. The DWR expects to conduct water quality sampling of these wells every three years, or as funds are available. The water quality data is disseminated on the DWR WDL.

The results for the USGS water quality sampling are available on the National Water Information System (NWIS) website[7]. The USGS sampled these wells as part of a larger investigation to document the condition of the groundwater throughout the valley. It is not expected that the USGS will routinely sample these wells.

The current water quality monitoring network consists of DWR owned multiple-completion monitoring wells with a sparse distribution covering the entire County. Routine sampling of these wells will allow for water quality trends to be identified. As stated within this GMP, the County does not own any dedicated monitoring wells. In conjunction with DWRs efforts to collect and distribute water quality information of the groundwater resource, the County encourages private water purveyors to disseminate their water quality data to aid in documenting depth specific and County-wide water quality trends.

7.1.3. Land Subsidence

Land subsidence has not been historically reported or documented within Sutter County. Nevertheless, DWR installed an extensometer and began monitoring for ground surface displacement in 1994. Measurements are recorded on a daily basis, offering real-time and site specific measurements. On a more regional scale, DWR and its cooperating agencies, have implemented the Sacramento Valley GPS Height Modernization Project which will provide significant enhancements to a Sacramento Valley subsidence monitoring program. It is reported by DWR that the GPS monuments will be re-surveyed approximately every three years. The monitoring of land surface elevations will allow for periodic measurements of permanent land subsidence induced by groundwater pumping and/or natural processes. The surveys will be conducted in accordance with the National Geodetic Survey Standards for two centimeter accuracy.

When used in conjunction with surface subsidence survey data (GPS), the extensometer data could aide in identifying whether subsidence is occurring over the total depth of the monitoring well.

7.1.4. Future Groundwater Monitoring

The County's existing monitoring network is described above. Groundwater monitoring within the County is currently conducted by DWR and local water purveyors. The County will continue to cooperate with DWR and encourage the local water purveyors to continue to monitor groundwater levels. Under the voluntary guidelines of SBx7-6, selected local water purveyors will continue to monitor groundwater elevations for their

[7] http://waterdata.usgs.gov/nwis

respective service area(s), along with the DWR, under protocols established by DWR. The possibility exists that in the future, DWR may cease their monitoring if they lose funding for groundwater level measurements, and the responsibility of groundwater level monitoring will be entirely upon the local water purveyors.

All new wells should be sampled for basic water chemistry (i.e. specific conductance, arsenic, manganese, and nitrate). Although not required, the County may, in the future, consider requesting copies of laboratory reports to be submitted through the permit process. Water quality results from wells sampled by DWR are routinely placed on the WDL, and are often sampled every three years, or as funding allows.

The overall subsidence monitoring program should continue to be monitored by the extensometer and GPS monuments throughout the County. The Sacramento Valley GPS Network incorporates existing GPS networks and monuments to create a regional network that covers part or all of Colusa, Sutter, Glenn, Butte, Yolo, Yuba, Tehama, and Placer Counties.

For the area encompassing the Sutter Buttes, which is outside of a DWR delineated groundwater basin, groundwater is likely contained in the fractures of the volcanic rock as well as in the marine sands that compromise the Sutter Buttes. The area encompassing the Sutter Buttes is primarily privately owned and groundwater use is unknown but is likely limited to domestic wells or stock watering wells. It is suggested that private well owners monitor groundwater levels at least twice a year (fall and spring) in order to realize changing conditions. It is also good practice to test the quality of the groundwater for health based constituents.

7.1.5. Local and Regional Groundwater Management Coordination

Coordinating local and regional groundwater management is important to meeting Sutter County's Groundwater Management Goals because groundwater, like other resources, does not respect administrative/jurisdictional boundaries, and actions outside the County can affect groundwater in the County. Further, in order to achieve the Groundwater Management Goals, the County needs to be an "effective participant" in local and regional management efforts and work cooperatively with water managers to conduct effective groundwater management. To be an "effective participant", the County needs to be informed of its groundwater conditions and activities underway or planned, which may affect the resources positively or negatively. With time and appropriate documentation of water management activities and monitoring, an understanding of the resources can be obtained so that groundwater conditions can be the result of deliberate water management choices.

Coordinating groundwater management across local and regional jurisdictions will contribute to ensuring a reliable water supply by working towards management of entire groundwater basins, not just the portions underlying the County. Involvement in regional activities will help ensure that activities outside of Sutter County that affect the reliability of the groundwater supply in the County can be addressed through regional management actions. This involvement will also help protect water rights because the County's involvement with regional groundwater management will allow it to be part of a larger group that can exert more influence in preserving water rights north of the Delta. Finally, regional coordination will help the County maintain local control by ensuring that the County's interests are represented in regional groundwater management activities.

Sutter County recognizes the importance of regional coordination, collaboration, and communication and is signatory to the "Four-County Group," which has evolved into the "Northern Sacramento Valley – Integrated Regional Water Management Group", consisting of Butte, Glenn, Colusa, Tehama, Shasta, and Sutter Counties.

In addition to the water management coordination addressed above, which is more at a technical and operational level, it is important that coordination occur at the policy level as well. This is especially important for effective and consistent operations within water purveyors whose geographic jurisdiction extends beyond Sutter County. The processes to addressing water transfers, in particular, are different in each of the three counties. It would be important, as the GMP is implemented and the institutional structure and management processes become solidified, that a dialogue be established with the neighboring counties to address the need for developing consistency in processes that affect the management and operation of the respective water purveyors.

7.1.6. State of the Basin Report - Groundwater Condition and Groundwater Management Plan Evaluation

In the future, Sutter County and local water purveyors may benefit from preparing an annual report of the conditions of its groundwater basin. However, the present County staffing and funding levels are unable to accommodate this work effort. Groundwater elevation data for the County will be available through the CASGEM program and continued DWR monitoring. Additionally, new and/or current water quality data is periodically submitted and is available through the DWR Water Data Library. The County encourages cooperation among all groundwater users to share data (groundwater level and/or quality) which is not reported or what is readily available through the Water Data Library. Water quality data is also accessible through the Department of Public Health for permitted public water systems. Through this report, the County will encourage its groundwater users to be responsible stewards of the County's resources.

This GMP prepared by the County is not intended to be a static document. As conditions change, such as population, land uses, or climate, it may be warranted to revisit the County's goals and BMOs to ensure that the overall goals of sustaining its groundwater resources to meet current and future demands for the County are being satisfied. The County encourages cooperation among its groundwater users to keep these goals in mind. It is not Sutter County's intent of this GMP to be an enforcer with regards to groundwater use; however, as climatic and groundwater usage change in the future, it may be necessary to "check in" and adjust or expand this GMP.

7.2. Action Plan

7.2.1. Actions for Groundwater Levels BMO

To avoid ongoing declines in groundwater, to avoid abnormally high groundwater levels, the County has taken and will take the following actions:

Action	***Frequency***	***Status***
Participation in the "Northern Sacramento Valley – Integrated Regional Water Management Group"	As needed	2008 - Present
Maintain relationships with state and federal agencies	Annual	1850 - Present
Promote conjunctive use through public outreach	Annual	2008 - Present
Coordination with local and regional jurisdictions on groundwater.	Annual	2008 - Present
Ensure compliance with adopted policies in 2008 General Plan (Goal ER 6)	Annual	2008 - Present
Review groundwater contour maps prepared by DWR	Annual	2008 - Present
Disseminate groundwater level data on County's website	As needed	2010 - Present

7.2.2. Actions for Groundwater Quality BMO

To improve the understanding of groundwater quality, the County has taken and will take the following actions:

Action	***Frequency***	***Status***
Cooperate with DWR in its monitoring efforts	Annual	2010 - Present
Maintain relationships with neighboring counties	Annual	1850 - Present
Ensure compliance with adopted policies in 2008 General Plan (Goal ER 6)	Annual	2008 - Present
Ongoing coordination with local and regional jurisdictions on groundwater	Annual	unknown - Present

7.2.3. Actions for Inelastic Land Subsidence BMO

To avoid inelastic land subsidence that is linked to declines in groundwater levels, the County has taken and will take the following actions:

Action	***Frequency***	***Status***
Cooperate with DWRs monitoring efforts	Annual	2010 - Present
Participate in the “Northern Sacramento Valley – Integrated Regional Water Management Group”	Annual	2008 - Present
Establish and update a groundwater management plan website	Annual	2008 - Present
Review data from the extensometer installed in Sutter County	6 months	2010 - Present
Maintain relationships with state and federal agencies	Annual	1850 - Present

7.2.4. Actions for Surface Water BMO

To improve the understanding of the relationship between surface water and groundwater; to avoid changes in surface water flow and surface water quality that directly affect groundwater levels or are caused by groundwater pumping; and to avoid changes in surface flow and surface water quality that directly affect groundwater quality, the County has taken and will take the following actions:

Action	***Frequency***	***Status***
Engage in the "Northern Sacramento Valley – Integrated Regional Water Management Group"	Annual	2008 - Present
Establish a groundwater management plan website	Annual	2008 - Present
Maintain relationships with state and federal agencies	Annual	1850 - Present
Ensure compliance with adopted policies in 2008 General Plan (Goal ER 5)	Annual	2008 - Present

7.2.5. Actions for Coordination BMO

To coordinate County groundwater management efforts with other groundwater management efforts within and surrounding Sutter County, the County has taken and will take the following actions:

Action	***Frequency***	***Status***
Engage in the "Northern Sacramento Valley – Integrated Regional Water Management Group"	Annual	2008 - Present
Maintain relationships with state and federal agencies	Annual	1850 - Present
Establish and update a groundwater management plan website	As needed	2008 - Present

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CITY OF LIVE OAK

City of Live Oak
Water Master Plan

December 2009

Prepared for
City of Live Oak

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Rocklin, CA 95765

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ENGINEERS · CONSULTANTS

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Water Master Plan

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Appendices

Appendix A Hydraulic Modeling Results
Appendix B Water Connection Fee Analysis

Executive Summary

This Master Plan has been prepared on behalf of the City of Live Oak (City). Projected water demands were developed for land uses within the City limits and within areas of the General Plan Sphere of Influence (SOI). Water supply improvements consisting of wells, treatment, distribution, storage and pumping facilities to provide capacity for future growth have been determined. The total cost of the improvements was then used to develop a revised water connection fee. A summary of the Water System Master Plan results and recommendations is included in this chapter.

ES.1 LAND USE AND WATER DEMANDS

Projections of future water demands within the service area were developed using land uses included in the City's draft General Plan. The water demand projections based on existing development as well as future growth within the General Plan SOI are summarized in Table ES-1.

Table ES-1
Projected System Water Demands [a]

Planning Boundary	Average Day, MGal/d (gpm)	Maximum Day, MGal/d (gpm)	Peak Hour, MG (gpm) [c]
Existing Development (including approved unbuilt demands) [b]	1.9 (1,310)	4.8 (3,320)	1.2 (4,960)
Build-out within City Limits (Infill)	2.5 (1,750)	6.4 (4,430)	1.6 (6,610)
Build-out of SOI	10.5 (7,300)	26.7 (18,540)	6.6 (27,670)

(a) Water demands based on annual average demand with peaking factors applied. Unaccounted water is included in the average annual demand, but the peaking factor is not applied to unaccounted water for calculating peak hour and maximum day.

(b) Demands are higher than observed metered demand data due to the inclusion of approved unbuilt demands. Approved unbuilt demands were included because system capacity has been committed to these parcels.

(c) Per Title 22, Chapter 15, Section 64552, R-13-03, peak hour needs be met for four hours.

ES.2 EXISTING SYSTEM

The existing distribution system is shown in Figure ES-1. Historically, water supply within the City has been from groundwater wells. The City's well network has been expanded over the years and consists of four wells and a distribution system. A 1.4 million gallon (Mgal) ground-level storage tank provides storage which supplements peak demands and maintains system pressure.

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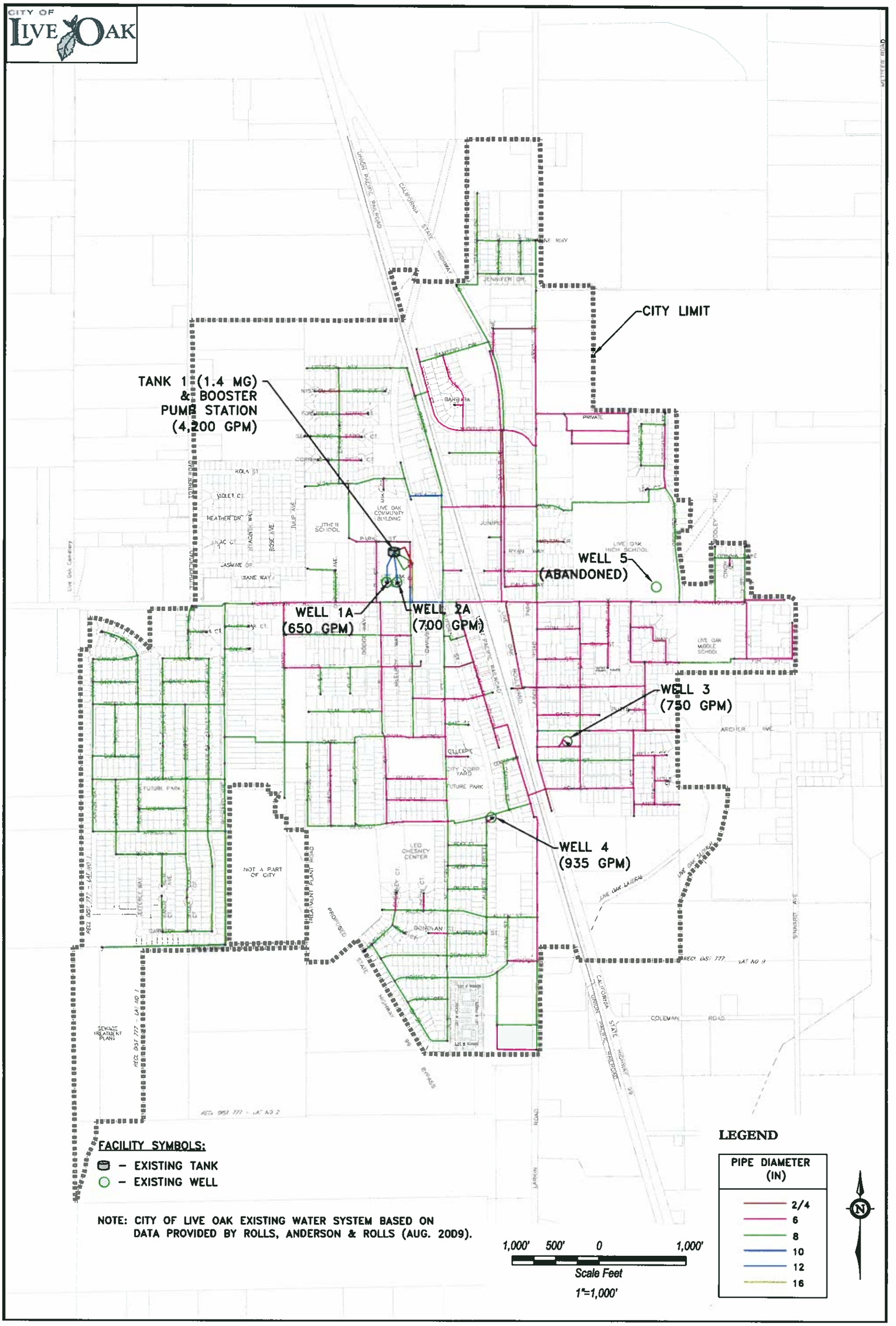

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CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE ES-1
EXISTING WATER SYSTEM

ES.2.1 Existing System Capacity

The well capacity with all wells operating is approximately 4.4 MGD; however, the reliable well capacity is 3.0 MGD, which is based on the largest well being out of service. The available supply for maximum day demand (MDD) plus fire flow including the wells and flow from the tank is approximately 8.5 MGD. The tank provides 1.4 MGal of storage.

The average observed maximum day demand from 2006 through 2008 is approximately 3.4 MGD. Per California Waterworks standards (Title 22, Chapter 15, Section 64554, R-14-03), the system shall be capable of meeting MDD with the highest-capacity source off line. There is currently not reliable capacity for maximum day demand, because the supply must come from wells and not storage. With all wells in service, there is enough supply to meet current observed maximum day demand. The estimated committed maximum day demand, including demand from approved unbuilt units is 4.8 MGD.

Including supply from the wells and the tank through the booster pump station there is not enough supply to meet current fire flow requirements and maximum day demands. There is enough storage to meet peak hour demand for the required four hours. Hydraulic restrictions within the existing distribution system also limit the flow and pressure during the peak demand periods causing fire flow requirements not to be met.

ES.2.2 Water Quality

All wells are sampled and tested for general mineral, general physical, bacteriological, inorganic, and organic chemical analyses in compliance with Title 22 requirements. Overall water quality from the wells meets the primary water quality criteria except for arsenic. After arsenic treatment was added to all wells, the wells have been in compliance with the arsenic Maximum Contaminant Level (MCL).

New wells will be required to meet the arsenic MCL. Based on historical water quality data from existing City wells, arsenic appears to be prevalent in the underlying groundwater. Treatment to remove the arsenic from the water will likely be necessary; however, treatment could potentially be avoided or reduced depending on the location and design of the well, but cannot be known until future wells are constructed.

Well 1 has exceeded the MCL for nitrate once. All wells have elevated nitrate levels, but are still below the MCL. Nitrate levels should be monitored closely in the City wells.

ES.3 RECOMMENDED IMPROVEMENTS

Water supply, treatment, storage, pumping and distribution improvements have been identified to meet future water demands and to correct existing deficiencies within the current system. A brief description and estimated costs are included below.

ES.3.1 EXISTING CONDITIONS

Remedies to meet current California Waterworks standards to provide reliable supply capacity include providing additional source capacity through construction of one new well with treatment. Additionally, replacing some smaller diameter pipelines would increase available fire flow capacity.

The estimated cost to address existing deficiencies is $5.8 million, and would be financed through rates. These costs include a 20-percent contingency and 20-percent allowance for engineering, administrative and legal fees.

ES.3.2 FUTURE CAPACITY

Improvements to increase system capacity to serve future growth include additional wells with treatment, extension of the distribution system, and additional storage and booster pump stations.

Future source capacity will be provided from new wells throughout the system. Future wells are expected to provide at least 2,000 gpm, but capacities could be higher. Eight new wells will be needed to serve future growth. If future wells have higher capacity, then fewer wells will be needed. New tank storage of 1.4 mgd and pumping facilities at 9,800 gpm will also be needed.

The estimated cost of the wells/treatment, distribution, pumping and storage is $49 million. The cost includes a 20-percent contingency and 20-percent allowance for administration, legal and engineering.

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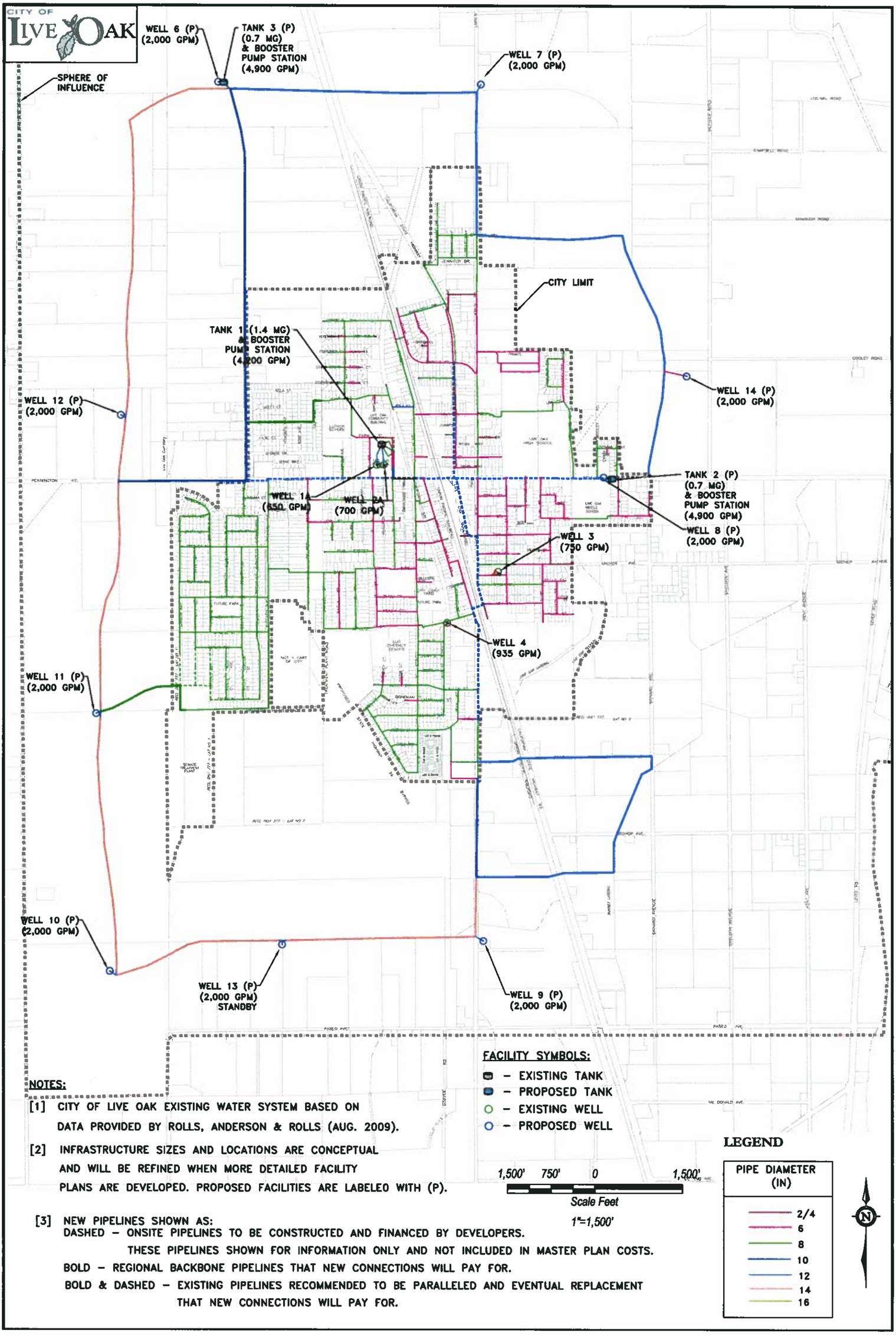

NOTES:

[1] CITY OF LIVE OAK EXISTING WATER SYSTEM BASED ON DATA PROVIDED BY ROLLS, ANDERSON & ROLLS (AUG. 2009).

[2] INFRASTRUCTURE SIZES AND LOCATIONS ARE CONCEPTUAL AND WILL BE REFINED WHEN MORE DETAILED FACILITY PLANS ARE DEVELOPED. PROPOSED FACILITIES ARE LABELED WITH (P).

[3] NEW PIPELINES SHOWN AS:
DASHED – ONSITE PIPELINES TO BE CONSTRUCTED AND FINANCED BY DEVELOPERS. THESE PIPELINES SHOWN FOR INFORMATION ONLY AND NOT INCLUDED IN MASTER PLAN COSTS.
BOLD – REGIONAL BACKBONE PIPELINES THAT NEW CONNECTIONS WILL PAY FOR.
BOLD & DASHED – EXISTING PIPELINES RECOMMENDED TO BE PARALLELED AND EVENTUAL REPLACEMENT THAT NEW CONNECTIONS WILL PAY FOR.

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CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE ES-2
BUILDOUT WATER SYSTEM WITH EXISTING DEFICIENCIES

ES.4 RECOMMENDED CONNECTION FEE

Facilities financed with connection fees include backbone facilities such as water supply, storage/pumping and distribution system improvements, which provide the necessary capacity to serve future growth. The cost of future expansions is assigned to future development and not existing residents.

Specific onsite improvements within specific developments that are needed to provide service to the development include distribution system piping, services, blow offs, fire flows in excess of normal requirements, and other appurtenances. Onsite improvements will be financed by the developer, constructed to City standards and deeded to the City. Onsite improvements are not included or credited to the connection fees.

The proposed water service fees for residential and non-residential water connections are included in Table ES-2. The fee includes three components:

1) **System Buy-In**: The system buy-in charge based on the City's existing water infrastructure assets. The analysis estimates the total cost of all of the assets at installation less accumulated depreciation.

2) **Future CIP Project Costs**: The future CIP project costs are based on the projected facility needs as identified in the Water Master Plan. These costs were split between existing and future users based on benefit. The costs allocated to future users are included.

3) **Meter Installation Costs**: The cost of installing and connecting a water meter to the City's distribution system is also included.

The proposed connection fees for residential and non-residential services under 1.5-inches are based on the anticipated demand and meter size. Connection fees for metered services larger than 1.5-inches should determined on a site-specific basis.

Table ES-2
Summary of Recommended Water Connection Fees

Service Type	Connection Fee
Residential Connection Fees	
Single Family	$7,398
Multi-Unit and Apartments	Site Specific
Non-Residential Connection Fee	
Meter Size, in	Connection Fee
5/8	n/a
3/4	$7,398
1	$11,370
Meter Size, in	Min. Connection Fee [(a)]
1.5	$21,399
2	$33,394
3	$72,543
4	$129,887
6	$283,290

(a) Recommended minimum connection fee; to be considered on site-specific conditions.

Chapter 1

Introduction

1.1 BACKGROUND

The City of Live Oak, California (City), located in the Sacramento Valley, is a community of approximately 8,500 people located along Highway 99 in a relatively urban environment. The City is located a short distance from major population centers and has the potential to significantly grow in the future. At this time the City is in the process of updating and/or generating new utility master plans for the anticipated future growth and to help identify any water infrastructure improvements required to address any current deficiencies. As a part of this process, this Water Master Plan has been developed to help identify existing water system issues and recommend system improvements to meet future growth within the planning area.

The existing City water supply and distribution system serves approximately 2,210 water service connections consisting of a mixture of schools, parks, residential, commercial, and industrial land uses. The existing City water supply system consists of four groundwater production wells, one ground level storage tank and booster pump station, and a network of distribution mains ranging in size from 4 inches to 16 inches in diameter. Two of the groundwater production wells pump directly into the 1.4 million gallon storage tank that provides suction water for the booster pump station. The combination of the booster pump station, and the two wells that directly supply water to the distribution system, maintain required system pressures.

This Water Master Plan was developed to provide the City with a recommended improvement plan that includes water supply wells, distribution pipelines, storage and pumping facilities to provide municipal water service for both the existing and identified future growth. The development of the Water Master Plan includes:

- Development of a logical expansion plan that can be phased based on growth projections and land uses.
- Projection of future water demands based on historical water use data and approved land uses as defined by City planning staff.
- Identify water infrastructure needs including supply, storage, pumping and distribution facilities.
- Develop opinion of probable costs for improvements that can be used in the establishment of appropriate water connection fees.
- Develop water connection fee recommendations.

1.2 SCOPE

The scope of work for this Water Master Plan consisted of the following major elements:

- Review of reports, drawings, land use and zoning maps, and other relevant drawings made available to ECO:LOGIC.
- Evaluate existing facilities, particularly in regards to how they will be impacted by future facilities.
- Develop future water demand estimates using planned land uses defined by the City's planning staff and existing water consumption data per existing land use type.
- Prepare a hydraulic water model of the water supply and distribution system using WaterGEMS Version 8i computer software.
- Evaluate existing water supply and distribution system. Identify existing system deficiencies and recommended infrastructure improvements to mitigate deficiencies.
- Evaluate planning level water infrastructure improvements to meet identified future water demands. These recommended improvements include supply, storage and distribution improvements to meet identified future growth and to maintain compliance with current applicable regulations including current California Waterworks Standards.
- Develop a planning level opinion of probable costs for identified infrastructure improvements and provide a recommended phasing for the improvements.
- Recommend an appropriate water connection fee schedule for future development identified within the current planning boundary.

1.3 ACKNOWLEDGMENTS

The cooperation, input, and support received from Aaron Orr and his staff at the City of Live Oak is gratefully acknowledged.

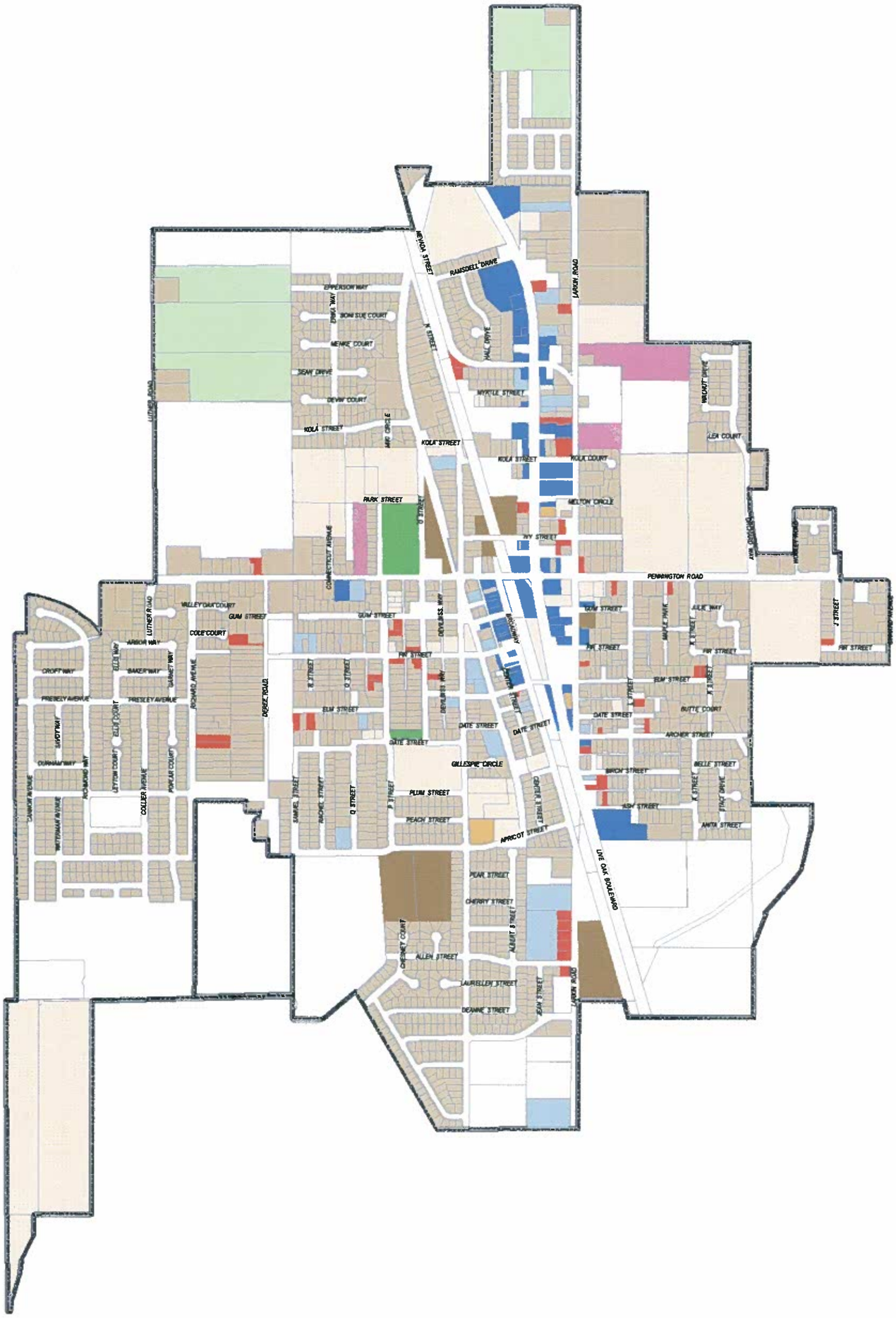
Chapter 2

Land Use and Water Demand

Estimates of future water demands, including the magnitude and location, are necessary to plan future water system improvements. Water demands are developed in this Chapter using existing and build-out land uses provided by the general plan consultant, EDAW AECOM, in April 2009. EDAW AECOM developed land uses for the City's draft General Plan. Projected water demands were estimated for land uses within the City limits and the City Sphere of Influence (SOI), as defined in the "Live Oak Preferred Alternative (New Growth Area)" figure prepared by EDAW AECOM in 2009, and shown on Figures 2-1 and 2-2. These areas are planned to be served by the City's water system. Areas outside the City SOI but still within the City's General Plan boundary are areas reserved for future growth, but have not been included in the current water infrastructure planning evaluation per direction by EDAW AECOM. Build-out within the SOI is estimated to occur by 2030 per EDAW AECOM direction and is part of the assumptions used in the development of the connection fee schedule. Actual growth will depend on a number of factors out of the City's control including the economy, interest by the development community to construct in the area, planned land use changes, and public support/opposition of new projects.

Unit water demand factors for each land use category were developed using meter data. These unit water demand factors were used in coordination with the land use, to project water demands.

CITY OF LIVE OAK



LEGEND

- CITY LIMITS
- CIVIC / PUBLIC
- COMMERCIAL
- DUPLEX
- INDUSTRIAL
- MOBILE HOME
- MULTI-FAMILY RESIDENTIAL
- OFFICE
- PARK
- RURAL RESIDENTIAL
- SINGLE FAMILY RESIDENTIAL
- NO WATER SERVICE

NOTES:

1. EXISTING LAND USES BASED ON GIS SHAPEFILE FROM EDAW APRIL 2009.
2. ONLY PARCELS PROVIDED WATER SERVICE ARE INCLUDED.

500 0 500 1,000

Scale Feet

N

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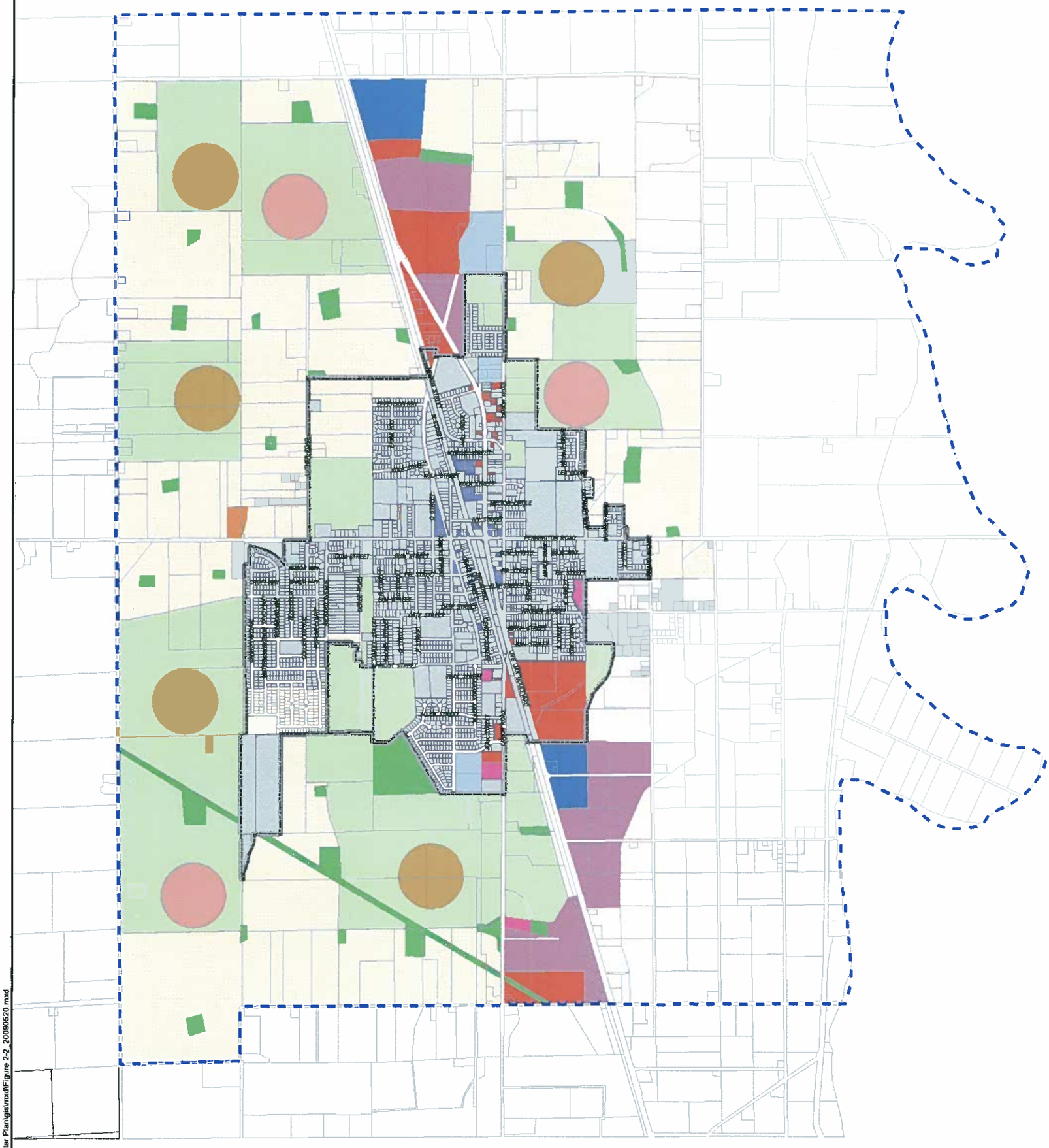
CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 2-1
WATER MASTER PLAN EXISTING LAND USE

CITY OF LIVE OAK



LEGEND

- SPHERE OF INFLUENCE
- CITY LIMITS
- EXISTING DEVELOPMENT
- CIVIC
- CIVIC CENTER
- COMMERCIAL MIXED USE
- COMMUNITY COMMERCIAL
- DOWNTOWN MIXED USE
- EMPLOYMENT
- HIGHER DENSITY RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- NEIGHBORHOOD CENTER
- PARK
- SMALL LOT RESIDENTIAL
- NO WATER SERVICE

NOTES:

1. FUTURE LAND USES BASED ON GIS SHAPEFILE FROM EDAW APRIL 2009.
2. ONLY PARCELS PROVIDED WATER SERVICE ARE INCLUDED.

1,000 0 1,000 2,000

Scale Feet

H:\Projects-Active\2008\LOAK\08-001- Live Oak Water Master Plan\gis\mxd\Figure 2-2_20090520.mxd

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CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 2-2
FUTURE WATER MASTER PLAN LAND USE

2.1 LAND USE

Existing and proposed land use types were provided by EDAW AECOM in April 2009. Residential land uses are defined in terms of dwelling units (DU), which represent one equivalent residential unit. Nonresidential land uses are defined in terms of acreages.

A summary of the existing and build-out land uses are listed in Tables 2-1 and 2-2, respectively. The land use designations differ between existing and build-out land uses.

Table 2-1
Existing Land Use Designations [a]

User	Existing DU/ acre	Notes
Civic/ Public	-	Represents public facility uses including schools.
Commercial	-	Represents commercial land uses including hotels, restaurants, convenience stores, veterinary hospitals, day care centers, banks, laundromats, carwashes, and churches.
Duplex	2	The duplex units were assigned as two units per parcel.
Industrial	-	Represents the range of industrial uses.
Mobile Home	13	
Multi Family Residential	8.1	
Office		Represents professional land uses including office buildings, medical offices, and dental offices.
Park	-	Represents public park lands. These are currently irrigated with potable water.
Rural Residential	1	The rural residential units were assigned as one unit per parcel.
Single Family Residential	1	The single family residential units were assigned as one unit per parcel to better match the known number of units.

(a) Dwelling unit densities and development percentage from EDAW AECOM in April 2009.

Table 2-2
Build-out Land Use Designations [a]

User	Developable Area Factor (i.e. not roads), % [b]	Future DU/acre	Notes
Civic	80%	-	Represents public facility uses including schools.
Civic Center	80%	-	Civic Center consists of the following land uses: HDR 22% Park 19% School 19% Civic 6% MDR 33% The per acre water demand factor includes water demand for all these land uses on an area weighted basis.
Commercial Mixed Use	80%	-	▪ Mixed use is defined as 10 percent medium density residential and 90 percent commercial. ▪ The demand factor includes water demand for both medium density residential and commercial.
Community Commercial	80%	-	Represents commercial land uses including hotels, restaurants, convenience stores, veterinary hospitals, day care centers, banks, laundromats, carwashes, and churches.
Downtown Mixed Use	80%	-	▪ Mixed use is defined as 10 percent medium density residential and 90 percent commercial. ▪ The demand factor includes water demand for both medium density residential and commercial.
Employment	80%	-	Represents professional land uses including office buildings, medical offices, and dental offices.
Higher Density Residential (HDR)	-	19.45	
Low Density Residential		3.89	
Medium Density Residential (MDR)	-	10	

User	Developable Area Factor (i.e. not roads), % [b]	Future DU/acre	Notes
Neighborhood Center	80%	-	Neighborhood Center consists of the following land uses: Commercial Mixed Use 22% HDR 36% Park 6% Civic 3% MDR 32% The per acre water demand factor includes water demand for all these land uses on an area weighted basis.
Park	80%	-	Represents public park lands. These are currently irrigated with potable water.
Single Family Residential	-	5.83	
Small Lot Residential	-	6.8	
Reserve	Reserve areas will not be served with potable water.		
Preserve	Preserve areas will not be served with potable water.		
Railroad	Railroad areas will not be served with potable water.		
Orchard	Orchard areas will not be served with potable water.		
Open Land	Open land areas will not be served with potable water as there is no landscaping.		
Buffer	Buffer areas will not be served with potable water.		

(a) Dwelling unit densities and development percentage from EDAW AECOM in April 2009. Build-out land uses are different than existing land uses.

(b) Factor represents the percentage of buildable land after land for roads and other infrastructure has been removed.

A summary of land uses within the existing city limits and sphere of influence are listed in the following sections.

2.1.1 Existing Land Use

Existing land uses were provided in a GIS shapefile by EDAW AECOM in April 2009. Existing land use of parcels with municipal water service is shown on the previous Figure 2-1. The acreage associated with each land use is listed in Table 2-3.

Table 2-3
Existing Land Use, acres [a]

Land Use	Total Acres [b]
Civic/ Public	t35
Commercial	23
Duplex	10
Industrial	20
Mobile Home	11
Multi Family Residential	19
Office	2
Park	6
Rural Residential	47
Single Family Residential	423
Total	696

(a) Based on existing land use GIS shapefile provided in April 2009 by EDAW AECOM. Only land uses with water demands are listed.

(b) Acreage has not been reduced to account for streets and infrastructure.

2.1.2 Build-out Land Use

Projected land uses with municipal service within the sphere of influence are shown in the previous Figure 2-2. The acreage associated with each land use is listed in Table 2-4. Future water demands were estimated using the acreages associated with each land use category, and represent the potential maximum water demand if properties are fully developed per the planned land uses. Per the General Plan, certain parcels were assumed to redevelop. The following land uses were generally assumed to be redeveloped: open land, orchards, rural residential, and single family residential areas on large lots that could develop to a higher density.

Table 2-4
Build-out Land Use Without Existing Land Use, acres [(a), (b)]

Land Use	Acres [(c)]
Civic	14
Civic Center	157
Commercial Mixed Use	138
Community Commercial	59
Downtown Mixed Use	13
Employment	189
Higher Density Residential	11
Low Density Residential	1,523
Medium Density Residential	51
Neighborhood Center	94
Park	130
Small Lot Residential	1182
Total	3,561

(a) Based on the land use GIS shapefile provided by EDAW AECOM in April 2009. Only land uses with water demands are listed.

(b) Includes redeveloped existing land use, but does not include existing land use.

(c) Acreage has not been reduced to account for streets and infrastructure.

2.2 WATER PRODUCTION

Existing water use in the City of Live Oak was estimated utilizing historical water data from the existing water supply wells. The production data represents the amount of water pumped into the distribution system but not necessarily the actual customer demand. The majority of that water is sold and accounted for; however, a portion of the water is unaccounted for and "lost". Review of the production data is useful to establish water demands, peaking factors, and quantify the water system losses.

2.2.1 SUMMARY OF WATER PRODUCTION

Daily meter readings are collected at all of the well sites and provide a means to calculate maximum day, monthly, and annual production. Water production data provided by the City from 2005 through 2008 was used for the current evaluation.

Annual Production

The combined annual water production from all of the municipal supply wells is summarized in Table 2-5. Annual water production varies depending on average temperatures, seasonal rainfall, and the amount of distribution system flushing the City performs. As can be noted in the data there is a significant reduction in water production between 2005 and 2006. Between the

summer of 2005 and 2006 water meters were installed and are probably the cause for a significant decrease in water usage between the two years.

Table 2-5
Annual Water Production

Year	Water Production, MG
2005	535.7
2006	488.0
2007	460.0
2008	469.1

Monthly water production from 2004 through 2008 is shown in Figure 2-3. As expected, production increased during the warmer summer months as a result of irrigation. The highest monthly usage occurred in 2005, which corresponds to the elevated annual production in that year.

Given that there is a significant change in water usage from 2005 to 2006, most likely due to the installation of water meters at all services, years following the installation of the water meters will be more applicable to the development of future demands. It is standard to continue to see reductions in water used for several years after the installation of meters and billing system based on actual usage. Therefore, 2005 water production data was not used in the development of future demands and peaking factors.

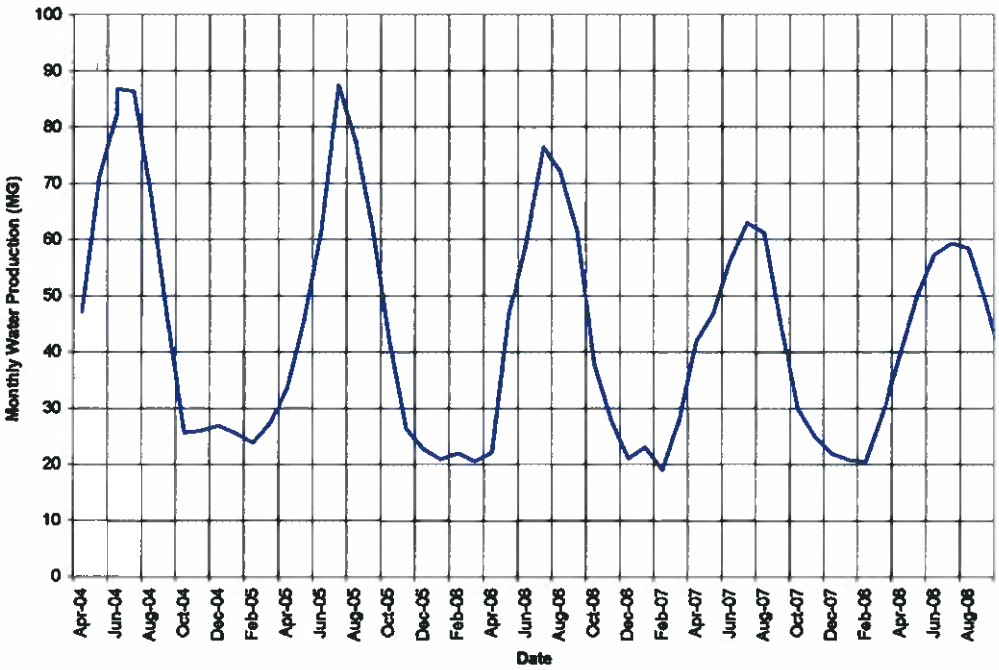


Figure 2-3
Monthly Water Production Data

Unaccounted Water

Unaccounted water is considered water that is produced and distributed but is not sold or metered. Sources of unaccounted water include leaks, slow meters, theft, fire protection, and unmetered water used for flushing dead ends within the system to maintain water quality.

Table 2-6 includes a summary of historical production and metered data that became available after 2006 with the installation of service meters. As shown in Table 2-6, the unaccounted water ranges from 0 to 4.2 percent. It is not clear why there is such a variation in the City's unaccounted water. The City replaced many of its old pipes with new pipes in 2008, which could explain the sudden reduction in unaccounted water in 2008 or it may be attributed to implementation of a new billing system associated with the newly installed service meters.

Table 2-6
Unaccounted Water

Year	Production, Mgal	Metered Water, Mgal	Unaccounted Water, %
2007	460	440.9	4.2
2008	469.1	469.2	0.0

Unaccounted water in the build-out model was assumed to be 4 percent based on 2007 data. Unaccounted water stays relatively constant throughout the year and therefore was added on top of projected demands without a peaking factor applied. Unaccounted water is included in the water demand projections discussed later in this Chapter.

Maximum Day (MDD) Water Production

Production data is typically the only daily data available because individual service meters are read on a monthly or bi-monthly basis and daily usage data is not available. In the case of Live Oak, the maximum day production would be expected to occur during the summer months, as is the case with most systems. The maximum day demand for 2008 occurred in August at 2.54 MGal/d. Maximum day to annual average productions were compared to calculate ratios as listed in Table 2-7. The average of the ratios was used as a peaking factor in projecting future maximum day demand.

Table 2-7
Maximum Day Water Production [(a)]

Month	Maximum Day Water Production, MGal/d	Annual Average Production, MGal/d	Ratio of Maximum Day to Annual Average Production
2006	4.9	1.3	3.9
2007	2.7	1.2	2.2
2008	2.5	1.4	1.8
Average	3.4	1.3	2.6

(a) Based on water production data.

The ratio of the maximum day to average daily demand of 2.6 was used for the purposes of this study, which is higher than normally observed. For example, the state of California recommends a peaking factor of 2.25 if no daily water production data is available, and a value of 2.5 is commonly used for planning purposes. The higher observed peak could be the result of the high temperatures typical of the Sacramento Valley where peak irrigation demands can spike during periods of extremely warm temperatures. The ratio of 3.9 in 2006 could have been the result of when the meters were read or some other abnormal event. This ratio is significantly larger than what would be expected. The industrial user does not cause an abnormal increase in maximum day demands which would skew the peaking factor.

Diurnal Production Pattern

Water demands in the City of Live Oak, as in all municipal water systems, are not constant throughout the day but vary with minimum flows typically occurring late at night with peaks occurring in the morning and again in the late afternoon/evening.

The peak demand periods typically occur between 5:00 a.m. to 9:00 a.m. when customers are waking, showering, and irrigating outside landscaping. A second peak demand period typically occurs between 4:00 p.m. and 8:00 p.m. when customers are arriving home after work, preparing meals and performing outside chores such as landscaping. Peaks can be reduced by encouraging irrigation during non-peak hours.

Well production meters are read daily, but no hourly data are available. Per California Waterworks standards (Title 22, Chapter 15, Section 64554, R-14-03) a peaking factor of 1.5 was multiplied by the maximum day demand to determine the peak hour demand. This peaking factor was applied to all demands within the City regardless of whether the water demand was residential or commercial.

Summary of Peaking Factors

The peaking factors developed in this section and used for predicting future water demands are summarized in Table 2-8.

Table 2-8
Water Use Peaking Factors

	Peaking Factor
Maximum Day/ Annual Average [a]	2.6
Peak Hour/Maximum Day [b]	1.5

(a) Based on well production data.
(b) Based on typical values for published data.

Water Production Per Capita

The water production per capita for 2006 through 2008 is shown in Table 2-9. Per capita production ranged from 151 to 179 gpd per person with an average of 162 gpd per person.

Table 2-9
Annual Water Production Per Capita

Year	Population [a]	Annual Water Production, MG	GPD per capita
2006	7,466	488.0	179
2007	8,119	460.0	155
2008	8,539	469.1	151
Average	-	-	162

(a) Based on population estimates from *State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2008, with 2000 Benchmark. Sacramento, California, May 2008.*

2.3 WATER DEMAND FACTORS

Infrastructure improvements to the water supply system necessary to serve future growth depend on the magnitude and location of the water demands. For master planning purposes, it is convenient to express the water demands for each type of development in the form of a water demand factor on a gallon per acre per day basis or gallon per day per dwelling unit.

The City of Live Oak's water system is metered and billing records include the type of service, and consumptive use information. The meter data from February 2006 through August 2008 were used to develop existing water demand factors by use type. The resulting annual average water demand factors are listed in Table 2-10.

Table 2-10
Annual Average Unit Water Demand Factors

Water User	Annual Average Water Demand Factor (gpd per acre or DU)
Existing	
Civic/ Public [a]	2,800 gpd/acre
Commercial [a]	1,500 gpd/acre
Duplex [a]	500 gpd/DU
Industrial [a]	2,000 gpd/acre
Mobile Home [a]	300 gpd/DU
Multi Family Residential [a]	300 gpd/DU
Office [a]	1,500 gpd/acre
Park [a]	3,000 gpd/acre
Single Family Residential [a]	500 gpd/DU
Rural Residential/ Ranch [a]	525 gpd/DU
Build-out	
Civic [a]	2,800 gpd/acre
Civic Center	3,912 gpd/acre
Commercial Mixed Use [a]	1,390 gpd/acre
Community Commercial [a]	1,500 gpd/acre
Downtown Mixed Use [a]	1,390 gpd/acre
Employment [a]	1,500 gpd/acre
Higher Density Residential [a]	300 gpd/DU
Low Density Residential [a]	500 gpd/DU
Medium Density Residential [a]	400 gpd/DU
Neighborhood Center	3,982 gpd/acre
Park [a]	3,000 gpd/acre
Small Lot Residential [a]	500 gpd/DU

(a) Calculated from meter data.

2.4 PROJECTED WATER DEMANDS

The land uses combined with the unit water demand and peaking factors were used to estimate future water demands under build-out conditions. The build-out demand condition is used to evaluate water supply improvements necessary to satisfy these demands and comply with applicable minimum design criteria and regulations regarding the provision of municipal water service.

The resulting water demand projections based on existing development and future build-out are listed in Table 2-11.

Table 2-11
Projected System Water Demands [a]

Planning Boundary	Average Day, MGal/d (gpm)	Maximum Day, MGal/d (gpm)	Peak Hour, MG (gpm) [c]
Existing Development (including approved unbuilt demands) [b]	1.9 (1,310)	4.8 (3,320)	1.2 (4,960)
Build-out within City Limits (Infill)	2.5 (1,750)	6.4 (4,430)	1.6 (6,610)
Build-out of SOI	10.5 (7,300)	26.7 (18,540)	6.6 (27,670)

(a) Water demands based on annual average demand with peaking factors applied. Unaccounted water is included in the average annual demand, but the peaking factor is not applied to unaccounted water for calculating peak hour and maximum day.

(b) Demands are higher than observed metered demand data due to the inclusion of approved unbuilt demands. Approved unbuilt demands were included because system capacity has been committed to these parcels.

(c) Per Title 22, Chapter 15, Section 64552, R-13-03, peak hour needs be met for four hours.

Chapter 4 includes a discussion of the water supply improvements to increase system capacity to serve future growth and the associated demands based on the projected water demands discussed in this section.

2.4.1 Phasing of Growth

The draft General Plan build-out land use was used to project water use in 2030. The water use was assumed to grow linearly from 2008 until 2030. The projected water demand by year is listed in Table 2-12.

Table 2-12
Phasing of Projected System Water Demands[a]

Year	Average Day, gpm	Maximum Day Demand, gpm	Peak Hour Demand, gpm [b]
2008	1,310	3,320	4,960
2010	1,850	4,700	7,020
2015	1,910	4,840	9,090
2020	3,270	8,300	11,150
2025	4,630	11,760	13,220
2030	7,300	18,540	27,670

(a) Water use was assumed to grow linearly from 2008 until 2030.

(b) Per Title 22, Chapter 15, Section 64552, R-13-03, peak hour needs be met for four hours.

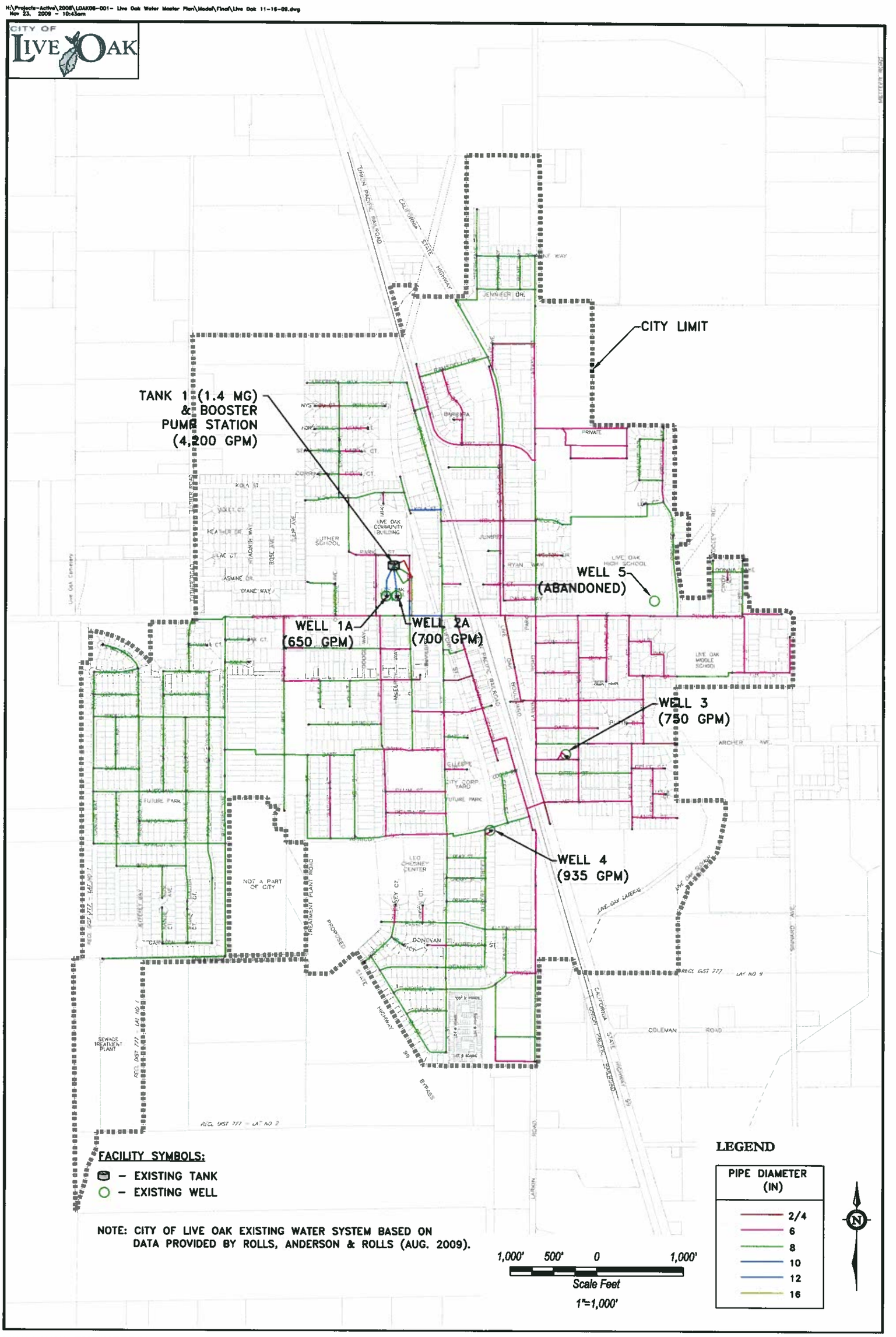
Chapter 3

Existing Facilities

A description of the existing water facilities, including wells, storage, pumping equipment and distribution system are included in this Chapter, along with a discussion regarding the water quality from each well. An assessment of the groundwater aquifer, and long-term ability of the aquifer to provide a reliable water supply is included in the City's Urban Water Management Plan (UWMP).

3.1 EXISTING WELL SYSTEM

Water supply for domestic water service and fire flow is supplied from four wells owned and operated by the City. The wells are numbered 1 through 4 and their locations are shown on Figure 3-1. Table 3-1 describes each well. Data included in the table is based on City input, and data excerpted from the Department of Health Service's Live Oak well information data sheet. Information includes details about the well construction, capacity and mechanical equipment. This information was not independently verified in the field and is strictly based upon information provided by others.



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CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 3-1
EXISTING WATER SYSTEM

Table 3-1
Well System Summary

Name		Well 1A	Well 2A
State Well Number (DWFOB)		17N/03E-32N01 M	17N/03E-32N02M
Location (Cross Streets, etc.)		Corporation Yard on O Street	Corporation Yard on O Street
Date Drilled		(1951)	(1951)
Neighborhood		Park	Park
Lot Size		5 Acres	5 Acres
Distance To: Sewer		75 feet to lateral	80 feet to lateral
	Sewage Disposal	Sewered area	Sewered area
	Abandoned Well	None	None
	Property Line	>100 feet	>150 feet
Housing:	**Type**	Block Building	None
	Condition	Good	NA
	Floor (material)	Concrete	Concrete
	Drainage	Good	Good
Well Depth		236'-7" (292 feet)	393 feet (210 feet)
Drillers Report on File (yes or no)		(Yes)	(Yes)
Casing:	**Depth(s)**	67'-5" (66 feet)	(66 feet)
	Diameter(s)	10-inch (13-inch)	10-inch (13-inch)
	Material	(Steel)	(Steel)
	Height above Floor	(8-inch)	(17-inch)
	Distance to perforations	120 feet (None)	110 feet (None)
	Surface Sealed (yes or no)	Yes (Yes)	Yes (Yes)
	Gravel Pack (yes or no)	Yes (No)	Yes (No)
	Annular Seal (depth)	(None)	(None)
Impervious Strata:	**Thickness**	3 feet	6 feet
	Depth to	43 feet	46 feet
Water Levels:	**Static**	11 feet (17.3 feet)	(11 feet)
	Pumping	(51.5 feet)	(37.2 feet)
Pump:	**Make**		
	Type	Submersible	Submersible
	Production (gpm)	1000-1100 GPM	1000 - 1100 gpm
	Depth to Bowls	Unknown	Unknown
	Lubrication	Water	Water
	Power	Electric motor 50 – HP	Electric motor 50 – HP
	Auxiliary Power	Yes	Yes
	Control	Tank Level	Tank Level
	Discharge Location	Above ground	Above ground
	Discharge To	Sand separator/Storage Tank	Sand separator/Storage Tank
Pump to Waste (yes or no)		Yes	Yes

Name		Well 3	Well 4
State Well Number (DWFOB)		16N/03E-05G01 M	16N/03E-05G03 M
Location (Cross Streets, etc.)		Archer St. side of alley	Apricot Street
Date Drilled		1960	1983
Neighborhood		Residential	Residential
Lot Size		21' X 50'	Triangle 75" X 270 feet
Distance To: Sewer		>100 feet	53 feet
	Sewage Disposal	Sewered area	Sewered area
	Abandoned Well	25' from original well	None
	Property Line	10 feet	16 feet
Housing:	**Type**	None	None
	Condition	NA	NA
	Floor (material)	Concrete	Concrete
	Drainage	Good	Good
Well Depth		426 feet	426 feet
Drillers Report on File (yes or no)		Yes	
Casing:	**Depth(s)**	370 feet	426 feet
	Diameter(s)	13-inch	16-inch
	Material	Steel	Steel
	Height above Floor	12-inches	12 inches
	Distance to perforations	100 feet	390 feet to highest
	Surface Sealed (yes or no)	Yes	Yes
	Gravel Pack (yes or no)	No	No
	Annular Seal (depth)	None	58 feet
Impervious Strata:	**Thickness**	45 feet	36 feet
	Depth to	47 feet	53 feet
Water Levels:	**Static**	11 feet	11 feet
	Pumping	1500 gpm	Not Available
Pump:	**Make**	Byron-Jackson	Jacuzzi
	Type	Vertical turbine	Vertical turbine
	Production (gpm)	1,100 gpm	1,340 gpm
	Depth to Bowls	Unknown	Unknown
	Lubrication	Water	Water
	Power	Electric motor 60 – HP	Electric motor 75 – HP
	Auxiliary Power	No	Yes
	Control	Pressure	Pressure
	Discharge Location	Above ground	Above ground
	Discharge To	Sand separator	Sand separator/ Hydropnuematic tank
Pump to Waste (yes or no)		Yes	Yes

Wells 1A and 2A have been modified due to the addition of a 1.4 million gallon water storage tank and booster pump station. The modifications included new pumps and reconstruction of the wells. The California Department of Health Services (DHS) considers the modifications to be of such an extent that the wells are now considered new water supply sources, and have been renamed as Wells 1A and 2A, and are referred as such throughout this document.

The City relies on Wells 1A, 2A and 3 for the majority of the water produced within the City. Wells 1A and 2A discharge directly to the storage tank. Water is then pumped from the tank into the distribution system using the booster pump station. Wells 1A and 2A are constant speed pumps and are controlled by the adjustable level set-point in the storage tank. Wells 1A and 2A are hard wired to run together when called on. The booster pump station is controlled by the SCADA.

Well 3 discharges directly into the distribution system and uses a variable frequency drive (VFD) control system. When in operation the VFD is programmed to maintain a discharge pressure of 61 pounds per square inch (psi). If the booster pump station is on, Well 3 is programmed to be on.

Well 4 discharges into a 5,000 gallon (nominal) hydropneumatic tank. Well 4 supplements the supply as needed and turns on at 40 psi and turns off at 55 psi. Well 4 historically has had problems with taste and odor. After arsenic treatment was installed, there has been no more complaints about taste and odor.

Well 5 has been decommissioned due to arsenic and nitrate. The City has no intentions of activating the well in the future.

Testing of Well 6 after drilling indicated nitrate concentrations above the allowed maximum concentration level, and the well was never developed as a water supply and was capped. The City has no intentions of activating the well in the future.

All of the well sites are secured with fences and locked gates. There are fiberglass buildings installed at all well sites to provide climate control for ferric chloride and better protection from vandalism. There is adequate space available for routine operation and maintenance except at Well 3. Well 3 is located on a small parcel in an alley behind some homes.

All of the wells and booster pump station, except Well 3, are equipped with diesel powered back-up generators with automatic transfer switches.

The treatment filters described in Section 3.5.7 limit the well production. Adding more filters would increase production capacity. However, there is no more room at Well 3 for filters. The maximum productivity even with different pumps and motors would be 1,000 gpm for Wells 3 and 4, 2,000 gpm for the combination of Wells 1A and 2A.

3.1.1 Chlorine Facilities

The City actively maintains a chlorine residual of one ppm within the distribution system. The City's groundwater supply is not considered to be under the influence of surface water, and chlorination is not required; however, system operators maintain a residual as a preventative measure against potential bacteriological contamination of the distribution system. Chlorine facilities at all of the sites consist of a chemical feed peristaltic pump and a storage tank.

The chlorine feed rate is flow based at a Well 3, and the tank. The chlorine dose at Well 4 is controlled manually, and requires very little adjustment because the pump discharges at a constant rate. Chemical feed pumps are started when the well pump starts and turnoff when the well pump shuts down. At the Well 1A/2A site, chlorine is injected at the well head, between the pump discharge and the storage tank. If needed, chlorine can also be added at the tank outlet.

Liquid sodium hypochlorite at 12.5 percent-concentration is purchased from a local supplier and stored in double contained tanks at each site. A 300-gallon tank is provided at Wells 1A and 2A, and 115-gallon tanks are provided at the other well sites. The tanks provided about one or two weeks of storage depending on demands, and is considered appropriate to minimize the degradation of the chlorine solution as it ages.

Typically, the chlorine residual within the distribution system is maintained between about 0.5 to 1 mg/L, which is well below the maximum disinfectant residual limit for chlorine of 4 mg/L, and is considered good practice.

3.1.2 Additional Appurtenances

Each of the wells has a flow meter to totalize the water produced from each well. Meters are read daily. Magnetic flow meters record and totalize flows from Wells 1A and 2A. Wells 3 and 4 each have turbine type flow meters. Hours of pump runtime are also recorded.

Each of the wells is controlled locally, and there is no centralized operating or monitoring system. The supervisory, control and data acquisition system (SCADA) only monitors the water level in the storage tank.

All of the wells are equipped with a sand separator on the discharge to prevent any sand from entering the distribution system.

3.2 STORAGE AND PUMPING FACILITIES

The City's 1.4 million gallon storage tank is located at the City's Corporation yard site, and is adjacent to wells 1A and 2A. The storage tank was constructed in 2005 to satisfy water demands resulting from development occurring in the western portion of the City. The tank and booster pump station provide additional pumping capacity and emergency storage for the entire system.

The booster pump station has a reliable capacity of 4,200 gallons per minute. There are four pumps, three duty and one stand-by, with a capacity of 1,400 gpm each. The pumps operate on a variable frequency drive (VFD), which vary the speed of the pump(s) to maintain the distribution system pressure at the set-point, which is typically around 60 psi.

The pump suction is directly from the storage tank. Table 3-2 summarizes the specifications of the storage tank booster pump station.

Table 3-2
1.4 Million Gallon Storage Tank Booster Pump Station Specifications

Item	Number or Name
Pump	American Marsh Pumps
Number	4 (3 duty 1 standby)
Type	horizontal split-case
RPM	1750
Capacity (each pump)	1400 gpm @ 145 feet
Control	Cutler Hammer VFD
Motor	TECO Westinghouse Motor Comp
Size	75 hp
RPM	1770
Voltage	230/450
Phase	3
Standby Power	Diesel Generator
Manufacturer	Kohler
Size	445 KW
Control	Automatic

Wells 1A and 2A pump directly to the tank. Typically the wells alternate between fill cycles. The pumps in Well 1A or 2A start and stop when the water level in the storage tank reaches the appropriate set-points. Typically the pump will start when the water level drops to 20-feet, and stop when the water level reaches 25 feet.

Operations staff report that during the summer, when water demands are high, the water level in the tank typically drops during the day, because demands exceed the capacity of Wells 1A and 2A. The tank level recovers during the night when demands decrease.

3.3 DISTRIBUTION SYSTEM

A summary of the distribution system by pipeline diameter and pipeline material is shown in Tables 3-3 and 3-4. Distribution system data were provided in August 2009 by Rolls, Anderson & Rolls. Pipeline diameters range from two to sixteen inches in diameter. The system is constructed from various types of materials including asbestos cement, ductile iron and PVC piping. For the most part, the distribution system is looped, which provides flexibility, improves water quality, and reduces pressure losses throughout the system. City staff flush mains approximately 24 hours per month.

In the last few years, the City has replaced many of the smaller diameter asbestos concrete, cast iron and galvanized steel pipes. The intent of the pipe replacement was to reduce the water system losses that may be caused by the older pipelines and to increase system conveyance capacity.

Table 3-3
Distribution System Summary by Pipeline Diameter [a]

Diameter (inch)	Length (miles)	Percentage
2	0.7	2
4	0.3	1
6	11.1	37
8	18.1	60
10	0.1	0
12	0.0	0
16	0.1	0
Total	30.4	100

(a) Data provided August 2009 by Rolls, Anderson & Rolls. Private distribution system pipes were included.

Table 3-4
Distribution System Summary by Pipeline Material [a]

Material	Length (miles)	Percentage
Asbestos Cement	8.4	28
Ductile Iron	6.4	21
PVC	14.5	48
Other	1.1	4
Total	30.4	100

(a) Data provided August 2009 by Rolls, Anderson & Rolls. Private distribution system pipes were included.

There is not a formal leak detection program, but the leaks are repaired when found or reported.

3.3.1 SERVICES

There are approximately 2,210 service connections that all have meters. The City design standards require copper or polyethylene service lines between the main and the meter. Overall City staff report that the services are in good shape.

3.3.2 HYDRANTS

There are approximately 267 fire hydrants throughout the City. The City exercises its valves and fire hydrants as required to perform periodic flushing of the mains. The City does not have a comprehensive program for exercising hydrants and valves. Some of the hydrant shut off valves are old, and do not shut off tight. The City is currently in development of a valve maintenance program which will standardize exercising of valves and develop a replacement schedule for defective valves.

3.4 EXISTING WATER SUPPLY CAPACITY

Water supply capacity from the wells depends on specific operating conditions, particularly groundwater level and system pressure.

Table 3-5 summarizes the pumping capacity of the booster pump station and Wells 1A, 2A, 3, and 4.

Table 3-5
City of Live Oak System Reliable Capacity

Well Number	Status	Reliable Capacity (GPM)
1A	Active	650
2A	Active	700
3	Active(a)	750
4	Active(a)	935
5	Abandoned	0
Booster PS	Active (assumes one pump off)	4,200
	Total Reliable System Pumping Capacity (Wells 3 and 4, and Booster PS) Wells 1A and 2A feed the tank.	5,885

(a) Based on data provided August 2009 by City.

3.4.1 Comparison of Existing Demand and Supply

The existing reliable supply capacity and demand scenarios are listed in Table 3-6.

Table 3-6
Existing Demand and Supply Comparison

Scenario	Reliable Supply	Average Day Demand[c]	Maximum Day Demand[c]	Maximum Day + Fire Flow Demand[d]	Peak Hour Demand [e]	Surplus/ (Deficit)
Existing Development-Annual Average (gpm)	2,100 [a]	1,310	-	-	-	790
Existing Development-Maximum Day (gpm)	2,100 [a]	-	3,320	-	-	-t,220
Existing Development-Maximum Day+ Fire (gpm)	5,885 [b]	-	-	7,320	-	-1,435
Existing Development-Peak Hour (MG)	1.4 [b]	-	-	-	1.2	0.2

(a) Includes Wells 1A, 2A, and 3. Well 4 is not included, because it is the largest source per Title 22, Chapter 15, Section 64554, R-13-03. The booster pump station is not included because average day and maximum day supply must come from the wells.

(b) Includes Wells 3 and 4 and booster pump station. The largest source out of service is the standby pump at the booster pump station.

(c) Demand includes committed unbuilt demands and is therefore higher than actual demand.

(d) Based on a fire flow of 4,000 GPM as discussed in Chapter 4.

(e) Per Title 22, Chapter 15, Section 64552, R-13-03, peak hour needs be met for four hours.

For existing conditions, the City does not have reliable supply capacity for maximum day. Furthermore, hydraulic restrictions within the existing distribution system limit the flow and pressure during the peak demand periods causing fire flow requirements not to be met.

3.5 WATER QUALITY

Public water supplies must meet water quality standards established to protect the public health and to assure consumer acceptance. "Domestic Water Quality and Monitoring Regulations" as adopted by the State of California include bacteriological; general physical; and inorganic, organic, and general chemical monitoring, testing, and maximum contaminant level requirements applicable to public water supplies (Title 22 requirements). It is our understanding that monitoring and testing of the City's water supply has been carried out in accordance with the applicable requirements. Results of these tests are discussed below and presented in Table 3-7.

3.5.1 Taste and Odor

Historically Well 4 has had taste and odor issues. After arsenic treatment was installed, taste and odor no longer appeared to be a problem. The well is operated during normal operation. No other taste and odor problems have been reported for the other existing municipal wells.

3.5.2 Bacteriological Quality

Based on the number of active water service connections, the City collects water samples for bacteriological analysis every month based on their October 2005 Bacteriological Sample Siting Plan (Department Of Health Services Public Water System Annual Inspection, February 7, 2007). Prior to October 2004 the City has had some water sample lab test results indicate the presence of bacteriological activity in the past. These are believed to have been the result of not following proper sampling protocols, and of inappropriate disinfection of well head water. There have been no positive bacteriological samples collected since October 2004.

3.5.3 Organics

Wells 1 and 2 have had positive samples for EDB and DBCP. The redrilled wells, Wells 1A and 2A, were non-detect for EDB and DBCP in their initial sampling in 2006. Wells 1A and 2A will continue to be sampled every three years. The sampling requirement for organics has been waived for the other wells.

The initial sampling for Well 2A on February 28, 2006 detected 1.06 μg/L MTBE that was confirmed in a second sample on April 21, 2006 with the result of 1.73 μg/L. The next quarterly sampling on October 9, 2006 produced a non-detectable MTBE result. Well 2A will continue to be sampled every three months for MTBE while the other wells will be sampled every six years.

3.5.4 Arsenic

Arsenic is a natural occurring element originating from erosion of natural deposits and is known to cause various types of cancer, harm the central and peripheral nervous systems, as well as heart and blood vessels, and cause serious skin problems with prolonged exposure to low concentrations in potable water. Arsenic has a Primary Maximum Contaminant Level (PMCL) which was lowered from 50 parts per billion (μg/L) to 10 μg/L in 2006. To address the lower arsenic regulation, treatment has been added to Wells 1A, 2A, 3, and 4, as discussed in Section 3.5.7. After adding treatment these wells have been in compliance with the arsenic standard since February 2009.

3.5.5 Nitrate

Historically, water pumped from Wells 1 and 2 have had higher nitrate concentrations than water from Wells 3 and 4. Nitrate concentration in Well 1 ranged from 8.9 mg/L in a sample taken on February 14, 1995 to 106.8 mg/L in a sample taken on April 7, 2005. This maximum value in Well 1 was the only recorded violation of the 45 mg/L MCL and based on subsequent sampling is considered to be an erroneous result, either due to lab or sampling errors. However, Well 1 has had other recent results of up to 35.6 mg/L taken on June 16, 2005, which is close to the MCL.

The nitrate concentration in Well 2 ranged from 13.7 mg/L in a sample taken on April 4, 1995 to 41.25 mg/L in a sample taken on August 22, 2005.

Natural nitrate concentrations in groundwater typically range from 0.1 to 10 mg/l. Common sources of nitrate in groundwater include contamination from human or animal wastes, and leaching of salts from fertilizers used in agriculture, and natural occurring salts in the groundwater.

Nitrate levels should be monitored closely in all of the City wells.

3.5.6 HARDNESS

Hardness in the range of 150 to 250 mg/l as CaCO3, (calcium carbonate) can be considered hard. As shown in Table 3-7, hardness of the water varies from a minimum of 164 mg/l at Well 1, to a maximum of 251 mg/l at Well 4. Although hardness reduces the cleansing capacity of soaps, it has little effect on synthetic detergents and is not considered a water quality problem below 300 mg/l.

Table 3-7
Water Quality Constituents of Concern

Chemical	MCL	Unit	Max Results	Date	Min Result	Date
Well 1/ 1A Water Quality Constituents of Concern						
Arsenic (after treatment added)	10.0	µg/L	13	1/9/08		
Nitrate (As NO3)	45	mg/l	106.80	04/07/05	8.90	02/14/95
Nitrate + Nitrite (As N)	10	mg/l	3.65	11/21/96		
Nitrite (As N)	10	mg/l	0.00	12/13/05		
Hardness (Total)	(a)	mg/l as $CaCO^3$	250.00	12/13/05	164.00	01/03/06
Well 2/ 2A Water Quality Constituents of Concern						
Arsenic (after treatment added)	10.0	µg/L	13	1/9/08		
Nitrate (As NO3)	45	mg/l	41.25	08/22/05	13.70	04/04/95
Nitrate + Nitrite (As N)	10	mg/l	3.86	11/21/96		
Nitrite (As N)	10	mg/l	<1	11/21/96	0.00	06/03/03
Fluoride (F) Natural Source	1.7	mg/l as $CaCO^3$	0.37	01/28/04	0.10	03/03/05
Hardness (Total)	--	µg/L	228.00	03/03/05	205.00	06/04/04
Well 3 Water Quality Constituents of Concern						
Arsenic (after treatment added)	10.0	µg/L	1.5	11/6/08		
Nitrate (As NO3)	45	mg/l	15.00	06/24/04	10.06	03/11/03
Nitrate + Nitrite (As N)	10	mg/l	2.68	11/21/96		
Nitrite (As N)	10	mg/l	<1	11/21/96	0.00	06/03/03
Fluoride (F) Natural Source	1.7	mg/l as $CaCO^3$	0.12	11/02/99		
Hardness (Total)	--	µg/L	175.00	06/24/04	167.00	03/03/05

Chemical	MCL	Unit	Max Results	Date	Min Result	Date
Well 4 Water Quality Constituents of Concern						
Arsenic (after treatment added)	10.0	µg/L	Below MCL			
Nitrate (As NO3)	45	mg/l	30.20	03/03/05	2.80	09/18/01
Nitrate + Nitrite (As N)	10	mg/l	3.02	11/21/96		
Nitrite (As N)	10	mg/l	<1	11/21/96	0.00	06/03/03
Fluoride (F) Natural Source	1.7	mg/l as $CaCO^3$	0.11	11/02/99		
Hardness (Total)	--	µg/L	251.00	03/03/05	203.00	06/24/04

(a) No regulated MCL, however, levels over 300 mg/l begin to affect aesthetics.

3.5.7 WELLHEAD TREATMENT

Wellhead arsenic treatment, using the high rate Pyrolusite method, was added in 2008 to four well sites including 1A/2A, 3, and 4. At each well site the added treatment components include skid mounted arsenic treatment vessels with manganese oxide media, chemical storage and chemical metering pump station. Chemicals used in the treatment process include ferric chloride, potassium permanganate, and sodium hypochlorite.

At the 1A/2A site, a backwash tank was also added to allow recycling of backwash water. However, the City currently does not recycle the backwash water. The backwash water is sent to a sand drying bed to separate the solids that are sent to the landfill. Due to site constraints at sites 3 and 4, the backwash water and sludge is disposed of into the existing sewer and treated at the wastewater treatment plant.

The wellhead treatment process monitoring system is connected to the existing SCADA system.

Chapter 4

Recommended Improvements

Water supply, treatment, storage, pumping and distribution improvements have been identified to meet future water demands and to correct existing deficiencies within the current system. Improvements are based on the background information presented in the preceding Chapters.

Improvements identified herein are based on a practicable and flexible means of expanding the water facilities to serve new growth and correct existing problems. A primary goal of the improvement staging is to minimize the necessary infrastructure and associated costs while ensuring a reliable water supply. A discussion of recommended planning level improvements considered necessary to provide an adequate future water supply is included below. Detailed engineering studies, environmental review and detailed design of the improvements will be necessary prior to constructing the improvements.

4.1 WATER SUPPLY AND TREATMENT FACILITIES

The City of Live Oak's water supply has historically been provided from groundwater wells, and groundwater is expected to remain the sole water supply for the City in the future. The methodology for determining the water supply and treatment facilities, including assumptions, is discussed in this section, and a description of specific improvements follows.

4.1.1 METHODOLOGY

The methodology used to identify water supply and treatment facilities is discussed below along with assumptions used regarding the configuration of future improvements including wells and treatment facilities.

Two critical water supply conditions must be met within the system:

- The reliable capacity of the water supply must meet short-term peaks when demands are high either due to diurnal variations in demand or due to fire flows, and
- The reliable capacity of the water supply must meet the maximum day demand condition, which represents the highest expected demand over a 24-hour period.

The critical short-term demand is the greater of either the maximum day plus fire flow (MDFF) condition or the peak hour (PH) demand. Currently, the MDFF condition is higher and governs, but as growth occurs the PH flow condition will exceed MDFF.

During the peak periods the system must be able to deliver the required flow from either the wells that pump directly into the system or pumped from the ground level tank. If demands

cannot be met, the system will experience low pressures, and/or areas within the system could experience water outages.

If adequate storage, and pumping from storage to the system is provided, the system's well capacity, does not have to meet the short-term peak demand condition (MDFF or PH). When the short-term demands exceed the well capacity, the storage tanks will provide the additional volume and the water level in the tank(s) will drop while the demand exceeds the supply. After the peak demand period subsides, and supply exceeds demands, the tanks will refill.

Operation of water systems utilizing storage in this manner is a common and accepted practice because it eliminates the need for excess supply capacity to meet short-term peaks. Not only does the addition of storage reduce the number of wells required in the system, but it can also result in a significant reduction in capital, operation and maintenance costs, especially if wellhead treatment is necessary.

The reliable well capacity within the system must be capable of supplying the maximum day demand. If the well capacity cannot meet the maximum day demand condition, then storage in the system, which was designed for four hours of peak demand, will draw down and the system runs the risk of losing system pressure, and/or running out of water over the course of the day. Reliable well capacity is defined as the largest well out of service.

The staging of the water supply improvements depends on demand growth, which will increase as residential, commercial and industrial development occurs within the City. Proposed water supply improvements (e.g. new wells, treatment and storage) need to be planned, designed and constructed prior to the actual growth that will create the demand.

Capital improvement items associated with additional water supply including new wells treatment, storage, tanks, and booster pumping are discussed below.

4.1.2 Groundwater Wells

Planning level assumptions regarding future wells are as follow:

- New wells will produce a minimum of 2,000 gallons per minute (gpm). Based on the well logs of the existing wells, the current production may be limited by the screened length and well casing size. Future wells may be able to produce more water by increasing the well casing size.
- Water quality will be similar to the existing wells and would require the same treatment as the existing wells. During well design the City should attempt to maximize water quality to avoid treatment, which could include deeper wells and/or screening selected intervals with the highest quality water.
- The underlying groundwater aquifer will provide adequate long-term water supply.
- Well water pumped into the system will be chlorinated.

- All new wells will be operated using a variable frequency drive (VFD) to adjust flow and pressure within the distribution system.
- Land needed for new wells will be provided by developers.
- New wells will be constructed inside a building and stand-by/emergency power will be provided utilizing a diesel powered generator and automatic transfer switch.
- The reliable system capacity will be sized so that MDD can be met with the largest well out of service.

4.1.3 TREATMENT

A detailed study of different arsenic treatment methods is beyond the scope of this master plan. The water quality of each well site will be different. A study of each new well's water quality will determine what level of treatment is required. Given the need for arsenic water treatment on existing wells, arsenic treatment will probably be required on new wells.

As the City expands the water supply, there are two concepts for the layout of arsenic treatment facilities, centralized treatment, or wellhead treatment. Centralized treatment would include one treatment plant with raw water conveyed from multiple wells to the treatment facility. Wellhead treatment would be similar to the existing treatment where arsenic treatment would be added at the well site. No raw water piping would be required. Alternatively, a treatment facility may be built for several wells in one region of the City. Planning level advantages and disadvantages for centralized treatment versus wellhead treatment are discussed below.

Centralized treatment has several advantages and disadvantages. The advantages of centralized treatment include the economy of scale for a larger facility, and potential cost savings of having one treatment facility to maintain and operate. Centralized treatment has several disadvantages. The first disadvantage is that all the new wells would be in close proximity. Due to heightened security, having all wells in the same area may not be desirable. For example, if a tanker truck spilled a hazardous chemical near the well field, all wells would be affected. Another disadvantage of having the wells in close proximity is the pumping interferences between wells. More energy would be spent pumping the wells, because there would be more drawdown with many wells next to each other. Furthermore, water supply will most likely be added incrementally as the demand occurs. Building a large treatment plant would require a large capital expenditure upfront. The actual treatment modules may be added incrementally, but the supporting infrastructure including site grading and site piping would need to be sized for build-out and constructed initially. If the water demand does not materialize, a large amount of capital would be spent unnecessarily.

The wellhead treatment has several advantages over centralized treatment including being able to build treatment only when the treatment capacity is needed, less pumping costs, no raw water pipelines, and not being dependent on one centralized area for source water. The disadvantage of wellhead treatment is the increased number of plants that would need to be operated.

The costs would vary between building a centralized treatment plant and wellhead treatment. Assuming that treatment needs to be built for nine 2,000 gallon per minute wells would require 25 MGD of treatment capacity. A centralized the plant may use several different technologies including green sand filters, coagulation with microfiltration or enhanced coagulation. Using a cost curve based on other plants, an average cost for a 25 MGD plant would be approximately a $1.70 per gallon or $39.1 million for a 25 MGD plant. In addition to the treatment cost, a raw water distribution system would be built from the well field to the treatment plant. Assuming approximately 12,000 feet of raw water conveyance pipelines ranging in size from 10 inches to 22 inches, the raw water system cost would be $2.4 million including a 20% contingency and 20% for administration and engineering costs.

For wellhead treatment, if a similar treatment system to what was built at Wells 1A/2A, construction costs would be approximately $1.2 million per well or $10.8 million for nine 2,000 gpm wells.

For the purposes of this master plan wellhead treatment was assumed to be installed at all future wells. As previously discussed, it is recommended that future wells be located and designed to try to eliminate the need for treatment.

Key assumptions for planning purposes regarding future treatment are summarized below:

- Future treatment units will be installed at individual wellheads thus eliminating the need for extensive raw pipelines to convey water to a centralized treatment plant.
- Future well treatment is assumed to be similar to the existing well treatment.

4.1.4 Storage Tank and Booster Pump Station

Storage and pumping facilities are discussed in this section. As previously noted, the addition of storage can reduce the system's source capacity by meeting short-term peaks from storage. The City currently relies on a ground-level storage tank in the middle of the City to meet peak demand and fire flow events.

Key assumptions for planning purposes regarding future storage and booster pumping are included below:

- Future storage tanks will be ground level and constructed of steel.
- Tanks will be located near a well which will fill the tank to help cycle the tank; alternatively site piping will allow the tank to be filled off the system (i.e. from other wells) or bypassed altogether.
- A booster pump station will pump water from the tank into the distribution system. System pressure will be maintained using a VFD or a hydropneumatic tank as determined during detailed design. A booster pump station will be sized to include the capacity of the well in addition to the flow from the tank.

- Chlorination facilities will be provided to pre-chlorinate water entering the tank and/or post chlorinate water as it leaves the tank.
- The tank will be operated in a manner to circulate water through the tank to prevent degradation of the water quality.
- The tank and booster pump station would be sized with a reliable capacity to supplement the system well capacity to meet the PH or MDFF condition. Emergency and equalization storage would not be included in the tank sizing.

New pipelines in the distribution system will be sized to convey peak flows from the tank site throughout the City to meet the design flow condition.

4.2 DISTRIBUTION SYSTEM

This section includes an analysis and discussion of the City's distribution system under current and future conditions. Key aspects of the analysis include an evaluation of:

- Flow characteristics of the existing system under average and peak demand conditions and development of improvements to mitigate existing deficiencies.
- Sizing of pipelines to serve new growth under average and peak demand conditions.
- Incorporating the location and design flow from water supply sources.

A hydraulic model was used to evaluate the existing pipeline system, determine the size and layout of future distribution facilities. The model allows for the analysis of multiple system configurations and demand scenarios. A summary of the key assumptions used in the model is included below.

4.2.1 HYDRAULIC MODELING SUMMARY

A hydraulic model of the Live Oak water distribution system was developed using Bentley's WaterGEMS V8i modeling software. The hydraulic model was used to determine the distribution system improvements. Summary tables of the model output are included in Appendix A and include node and pipe reports for existing conditions, and build-out with existing deficiencies.

Scenarios Analyzed. The water distribution system model development included three scenarios including:

- Existing distribution system to assess flow and pressure conditions under current conditions.
- Modified distribution system to mitigate deficiencies identified in previous scenario.
- Build-out of the system to serve future growth without existing deficiencies mitigation facilities.

Demand conditions analyzed for each scenario included average day demand (ADD), maximum day demand (MDD) and peak hour demand (PHD). Fire flow analyses were conducted during MDD conditions.

Existing system demands were estimated using historical customer usage data. Future demands were estimated by applying unit demand factors to the parcels within the planning area based on the type of land use. GIS software was used to calculate and spatially allocate average day and maximum day demands to model nodes based on the land use based on land uses discussed in Chapter 2.

4.2.2 Model Input and Design Criteria

The basic input and design criteria used in the model are summarized below.

Model Node Elevations. USGS information, including topographic maps and existing electronic benchmark data, were obtained and used to populate model nodes with elevations. There were no topographic surveys used to ascertain elevations, and were not considered necessary due to the relatively flat terrain within the study area.

Distribution System Pressures. Maximum system pressure is based on the booster pump station pumping pressure. The minimum distribution system pressure requirement is based on Sutter County design standards as follows:

- Average Day- ≥40 psi
- Maximum Day- ≥40 psi
- Peak Hour- ≥30 psi

Distribution Pipe Sizing. The pipes in the model were sized according to the following design criteria. Design criteria is from the City and supplemented by the County design criteria where no criteria were available in the City.

- Minimum pipeline diameter of 8 inches for all new and replaced pipelines.
- Pipe velocities should not exceed:
  - Maximum day demand- 5 fps
  - Peak hour- 7 fps.
- New piping "C" factor is 125.

Fire Flow Analysis. Fire protection is provided by Sutter County as the City does not have a fire department. The required fire flows are based on Sutter County standards. The following fire flow assumptions were applied:

- The critical design condition was maximum day plus fire flow (MDFF).
- The distribution system's ability to provide fire flow was analyzed. No attempt was made to model detailed hydrant connections and size hydrants, which could reduce flow depending on the configuration lateral, isolation valve and type and size of the hydrant.

- Maximum pipe velocity of 10 fps during the MDFF condition.
- Minimum residual distribution system pressure of 20 psi during MDFF condition.
- Single-family residential fire flows are 1,500 gpm for two hours.
- Multifamily fire flows are 2,500 gpm for three hours.
- Commercial and Light Industrial fire flows are 3,000 gpm for three hours.
- School fire flows are 4,000 gpm for four hours.
- Future developments will be responsible for augmenting fire flow where flow requirements in excess of 4,000 gpm are required.

4.3 RECOMMENDED IMPROVEMENTS

The following summarizes the water supply, storage, and distribution system improvements being recommended as a result of the planning level hydraulic modeling evaluation. The recommended planning level improvements address identified existing deficiencies and need to serve future growth within the planning area.

4.3.1 EXISTING DEFICIENCIES

The City of Live Oak hydraulic water model was used to evaluate the existing system for possible water system deficiencies and develop water facility improvement recommendations to mitigate the identified deficiencies. The following section summarizes the results of this evaluation.

Source Capacity

Per California Waterworks standards (Title 22, Chapter 15, Section 64554, R-14-03), the system shall be capable of meeting MDD with the highest-capacity source off line. The existing reliable supply of Wells 1A, 2A, 3 is not sufficient to meet MDD. Therefore, a new well needs to be added. As discussed in Section 4.1.2, the future well is expected to provide at least 2,000 gpm.

Distribution System

The current distribution system is reliable and provides adequate service during normal flow conditions. The existing system is well looped, which increases flow and operational flexibility. However, the current fire flow requirements exceed the capacity of some portions of the existing water system. It should be noted that it is likely portions of the City water system were constructed before the current, higher fire flow requirements were adopted. The smaller diameter pipes in the existing water system cannot deliver the required fire flows due to high frictional head losses associated with high water velocities, resulting in pressure decreases below the minimum fire flow distribution system pressure of 20 psi. The existing available water system fire flows are shown in Figure 4-1.

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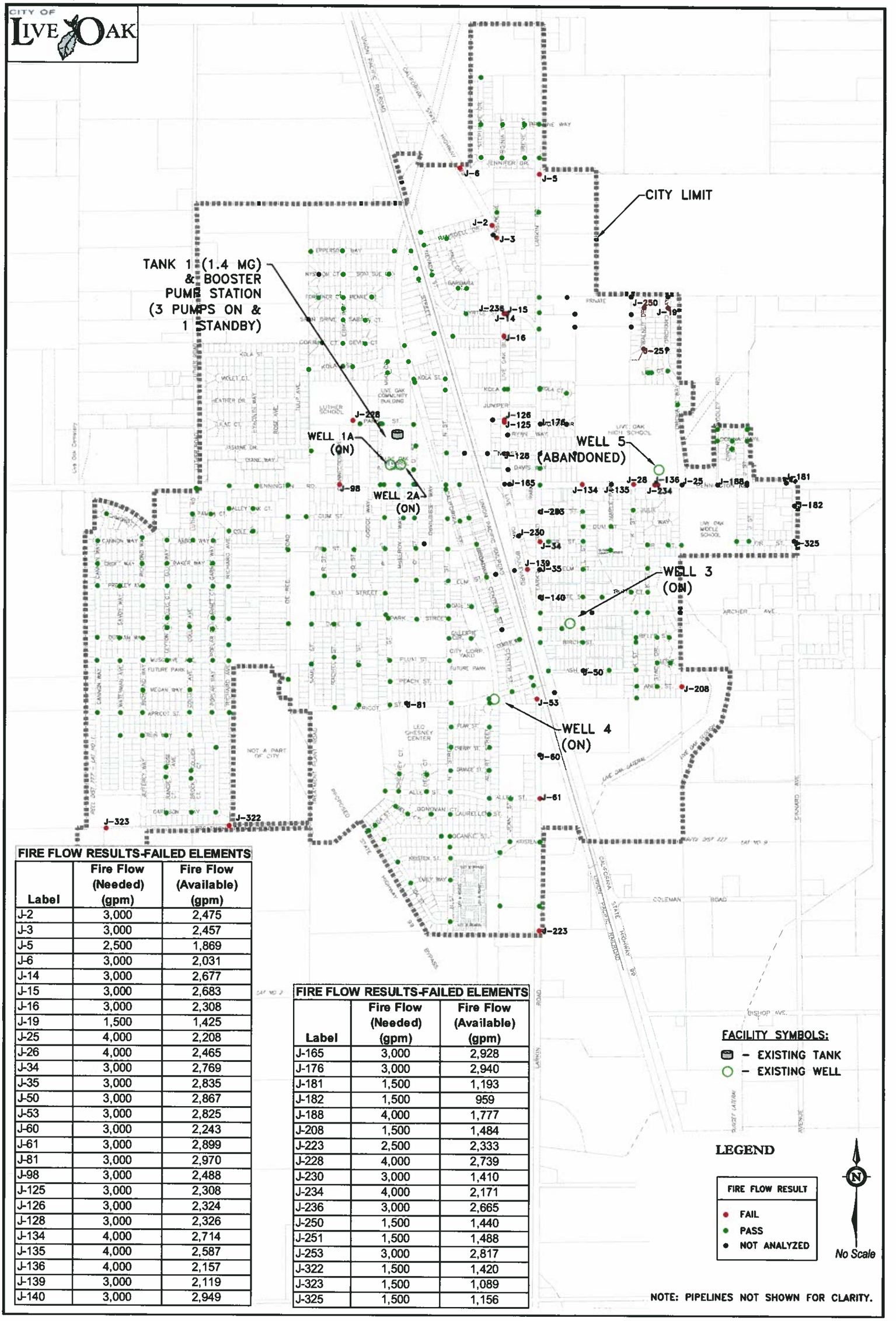

FIRE FLOW RESULTS-FAILED ELEMENTS

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)
J-2	3,000	2,475
J-3	3,000	2,457
J-5	2,500	1,869
J-6	3,000	2,031
J-14	3,000	2,677
J-15	3,000	2,683
J-16	3,000	2,308
J-19	1,500	1,425
J-25	4,000	2,208
J-26	4,000	2,465
J-34	3,000	2,769
J-35	3,000	2,835
J-50	3,000	2,867
J-53	3,000	2,825
J-60	3,000	2,243
J-61	3,000	2,899
J-81	3,000	2,970
J-98	3,000	2,488
J-125	3,000	2,308
J-126	3,000	2,324
J-128	3,000	2,326
J-134	4,000	2,714
J-135	4,000	2,587
J-136	4,000	2,157
J-139	3,000	2,119
J-140	3,000	2,949

FIRE FLOW RESULTS-FAILED ELEMENTS

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)
J-165	3,000	2,928
J-176	3,000	2,940
J-181	1,500	1,193
J-182	1,500	959
J-188	4,000	1,777
J-208	1,500	1,484
J-223	2,500	2,333
J-228	4,000	2,739
J-230	3,000	1,410
J-234	4,000	2,171
J-236	3,000	2,665
J-250	1,500	1,440
J-251	1,500	1,488
J-253	3,000	2,817
J-322	1,500	1,420
J-323	1,500	1,089
J-325	1,500	1,156

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CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 4-1
EXISTING WATER SYSTEM FIRE FLOW ANALYSIS

Hydraulic modeling was performed to develop planning level water facility improvements to address the fire flow deficiencies identified. The recommended water facility improvements to mitigate the fire flow deficiencies are shown in Figure 4-2. It is proposed that the existing pipelines will be paralleled with a new pipeline that has enough capacity to eventually abandon the original pipeline. The parallel mains are being recommended, instead of replacing the existing lines, as the age of existing distribution system is unknown. Some new pipelines are also recommended to fix the existing fire flow deficiencies.

The paralleling of the pipelines is expected to occur over time. The City should consider developing a detailed improvement plan that prioritizes specific improvements so that the most benefit can be realized as soon as possible. Prioritization would be based on several criteria such as:

- Severity of the fire flow deficiency
- Planned roadway improvements coupled with pipeline replacement to avoid resurfacing costs
- Type of development and anticipated risk of fire
- Frequency of leak repairs on particular segments
- Water quality complaints

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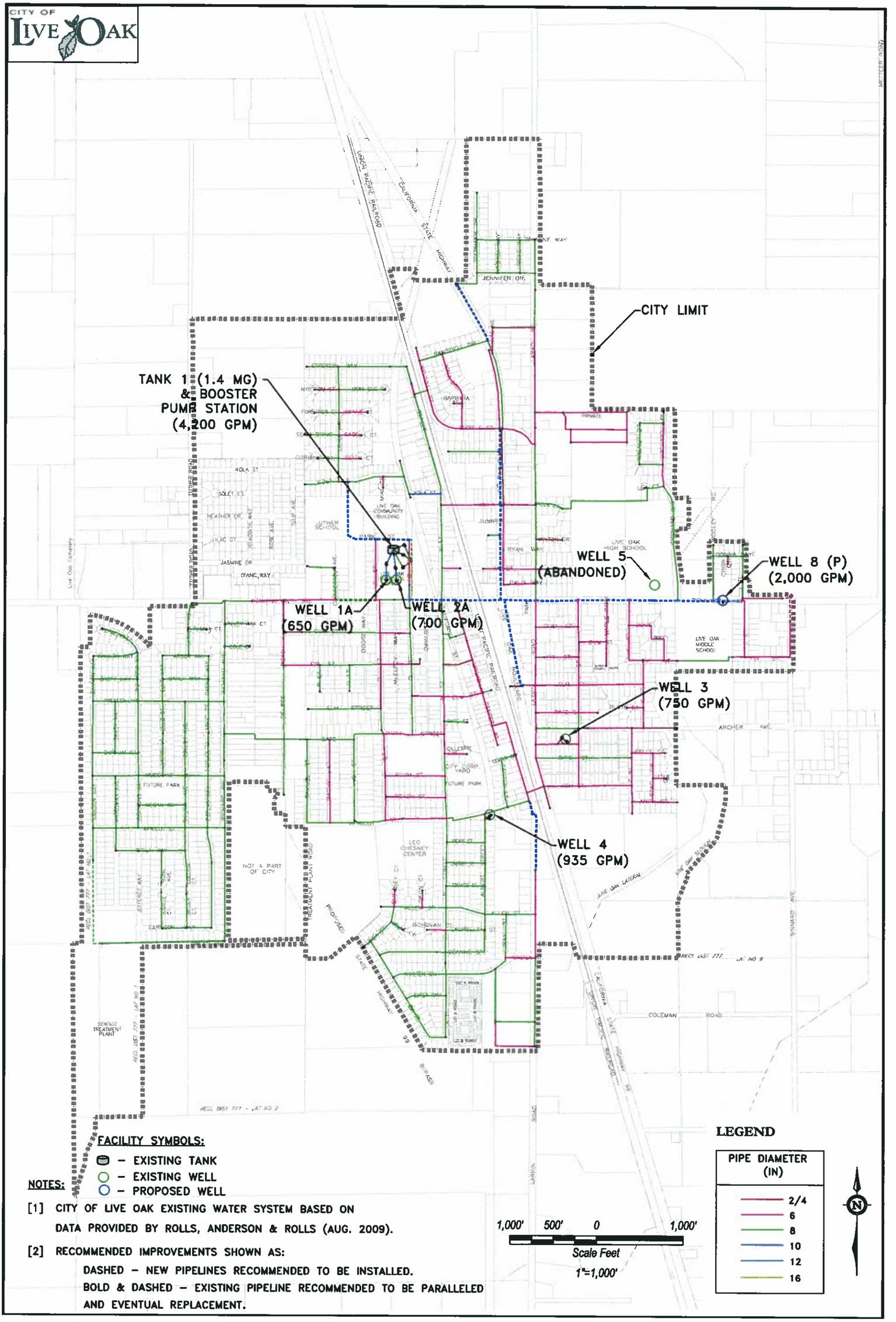

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FIGURE 4-2
PROPOSED IMPROVEMENTS TO MEET EXISTING FIRE FLOW REQUIREMENTS

Estimated Capital Costs – Existing Deficiencies

Opinions of probable cost are based on unit costs listed in Table 4-1.

Estimating costs to parallel existing pipelines is difficult without a detailed investigation. Factors that affect the cost include:

- Characteristics of the alignment including the amount of traffic, condition of existing roadway, other utilities in the area, etc.
- Construction bidding climate at the time of bidding.

A unit cost of $12 per inch per linear foot has been used based on other recent rehabilitation projects. Correction of existing deficiencies is normally financed through rates, not by connection fees as discussed in Chapter 5.

The estimates are based on the planning level evaluation and do not include site specific conditions, therefore a 20 percent contingency is included. Soft costs also represent a significant portion of capital improvement projects and include design, administration/legal and construction inspection and are estimated to be 20 percent of the total construction costs.

Table 4-1
Cost Basis

New Pipeline Cost	$10/in/LF
Parallel Pipeline Cost	$12/in/LF
Storage Tank Cost	$1/gal
Pump Station Cost	Based on recent bid data
Admin and Engineering	20% of capital cost
Contingency	20% of capital cost

Estimated costs for the improvements to parallel the small diameter pipelines are listed in Table 4-2.

Table 4-2
Proposed Improvements to Mitigate Existing Deficiencies
Opinion of Probable Cost [a]

Description	Qty.	Unit	Unit Cost	Total Cost
Well with treatment	1	Each	$2,700,000	$2,700,000
10" near Luther School and along Park Street	1,335	Length Feet	$120	$160,000
8" along O Street-new pipe	275	Length Feet	$80	$20,000
10" along Hwy 99	3,770	Length Feet	$120	$450,000

Description	Qty.	Unit	Unit Cost	Total Cost
8" along Pennington Road	515	Length Feet	$96	$50,000
10" along Pennington Road	3,520	Length Feet	$120	$420,000
10" along Larkin Road	850	Length Feet	$120	$100,000
8" along Cannon Way	1,060	Length Feet	$80	$80,000
6" along Sinnard Avenue	345	Length Feet	$60	$20,000
			Subtotal	**$4,000,000**
			Contingencies at 20%	$800,000
			Subtotal	$4,800,000
			Administration, Engineering @ 20%	$960,000
			Total	**$5,760,000**

(a) 20 Cities ENRCCI = 8,578 June 2009

4.3.2 Recommended Improvements - Build-out

Improvements to provide additional capacity to meet future demands are discussed in this section. These improvements are to expand system capacity to serve new growth and would be financed through connection fees.

Source Capacity

Future water capacity will be provided from new wells throughout the system. As discussed in Section 4.1.2, future wells are expected to provide at least 2,000 gpm. A total of 8 new wells will be needed. If future wells have higher capacity, then fewer wells will be needed. For planning purposes each well is assumed to be equipped with a treatment unit for arsenic removal.

Each well added to the system will require operation and maintenance attention, especially if treatment is needed. Therefore, limiting the number of wells is desirable. The number of wells can be reduced by:

- Maximizing the capacity of new wells
- Providing a storage tank and booster pump station

Attempting to design future wells with larger capacity should be a goal in the future, but will be limited to the aquifer characteristics. The addition of tanks and booster pump stations to meet peak demand periods to reduce the number of wells in a system is common practice, although the addition of a tank and pump station have some disadvantages:

- Tanks are typically unpopular with neighbors
- There is a loss of efficiency created when the water is pumped multiple times, once into the tank, and then into the distribution system
- The tank and booster pump station require maintenance

A preliminary new storage capacity of 1.4 Mgal (two tanks) has been identified in this master plan; however, the final storage volume should be evaluated as the production capacities of new wells are determined. If well capacity alone can provide adequate source capacity, the tank may be eliminated. Therefore, the City should plan to add two or three wells, assess the water quality and production rate from the wells, and then make a determination whether or not to add a tank and booster pump station and what size to make it.

The tank/pump station would eliminate three 2,000 gpm wells and the associated treatment units (if needed), which would provide significant savings to the cost of future improvements. Therefore, the proposed improvements include the tank and booster pump station. The decision to construct the tank should be deferred until the maximum reliable yield of future wells is determined and whether or not treatment will be required. Lower well yields and need for treatment will drive the decision in favor of adding additional tank storage.

Two tank locations are shown in Figure 4-3. A future well site could be initially developed without a tank. The well would pump directly into the distribution system until a tank were added, at which time the pump would be modified by changing the size or number of impellers and then pump to the tank at the lower pressure. The booster pump station would pump water from the tank to the system.

The combined build-out capacity of the two booster pump stations would be about 9,800 gpm based meeting peak hour demands. The initial pump station piping and layout would be designed to accommodate the 9,800 gpm flow, but the initial capacity constructed would be somewhat less depending on system demands and well outputs. Overtime, additional pumps would be added to the pump station, or the existing pumps upsized.

Based on the phasing described in Chapter 2, a summary of the water supply phasing is listed in Table 4-3.

Table 4-3
Phasing of Water Supply [(a)]

Year	Additional Wells	Total Wells	Additional Booster PS Capacity (gpm)	Total Booster Pump Station Capacity (gpm)	Additional Storage (MG)	Total Storage (MG)
2009	0	4		4,200		1.4
2010	3	7		4,200		1.4
2015	2	9		4,200		1.4
2020	1	10		4,200		1.4
2025	2	12		4,200		1.4
2030	1	13	9,800	14,000	1.4	2.8
Total	9	13	9,800	14,000	1.4	2.8

(a) Water use was assumed to grow linearly from 2009 until 2030.

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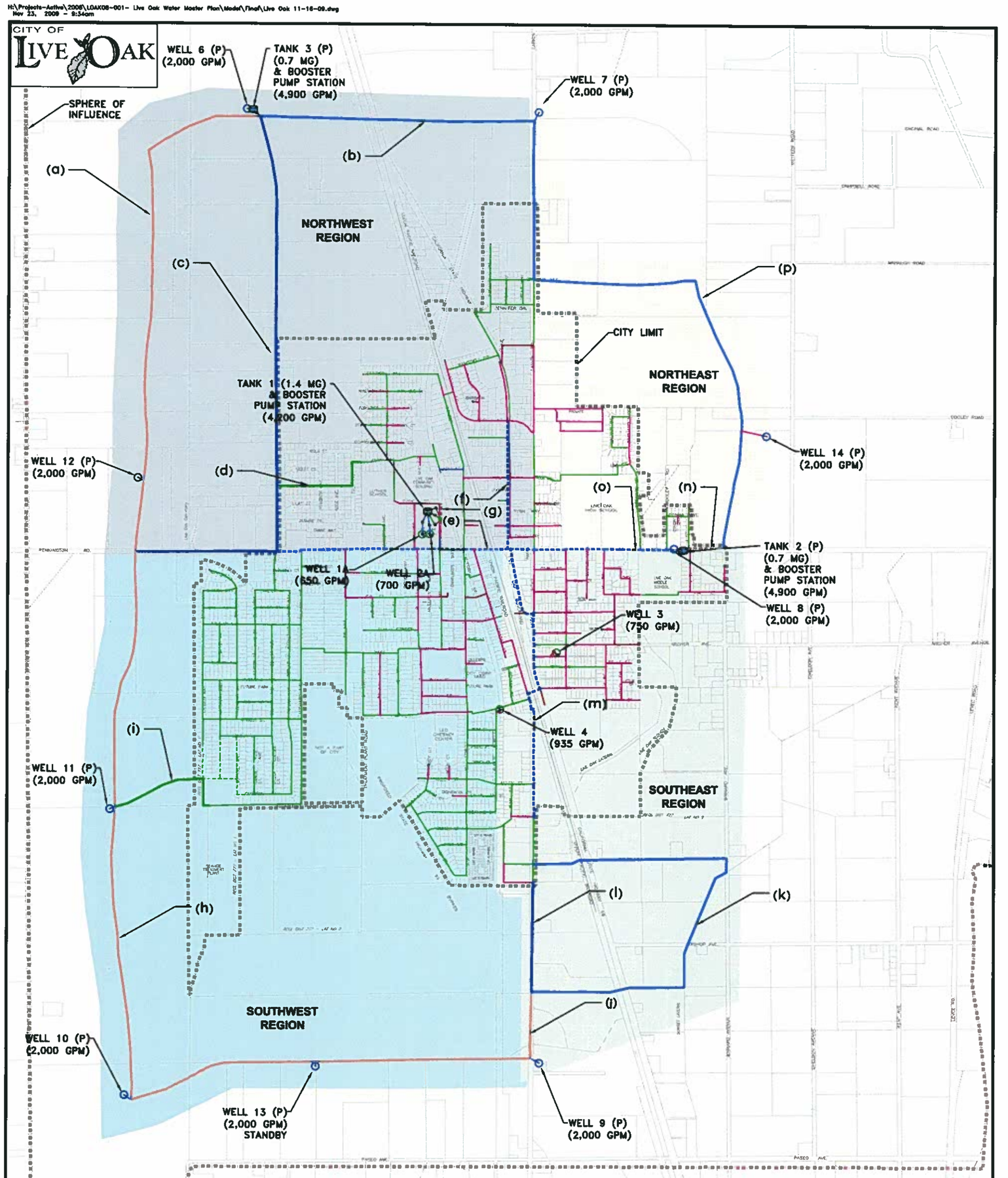


NOTES:

[1] CITY OF LIVE OAK EXISTING WATER SYSTEM BASED ON DATA PROVIDED BY ROLLS, ANDERSON & ROLLS (AUG. 2009).

[2] INFRASTRUCTURE SIZES AND LOCATIONS ARE CONCEPTUAL AND WILL BE REFINED WHEN MORE DETAILED FACILITY PLANS ARE DEVELOPED. PROPOSED FACILITIES ARE LABELED WITH (P).

[3] (a) – REFERENCE TO COST TABLE.

[4] NEW PIPELINES SHOWN AS:

DASHED – ONSITE PIPELINES TO BE CONSTRUCTED AND FINANCED BY DEVELOPERS. THESE PIPELINES SHOWN FOR INFORMATION ONLY AND NOT INCLUDED IN MASTER PLAN COSTS.

BOLD – REGIONAL BACKBONE PIPELINES THAT NEW CONNECTIONS WILL PAY FOR.

BOLD & DASHED – EXISTING PIPELINES RECOMMENDED TO BE PARALLELED AND EVENTUAL REPLACEMENT THAT NEW CONNECTIONS WILL PAY FOR.

FACILITY SYMBOLS:

- EXISTING TANK
- PROPOSED TANK
- EXISTING WELL
- PROPOSED WELL

1,500' 750' 0 1,500'

Scale Feet

1"=1,500'

LEGEND

PIPE DIAMETER (IN)
2/4
6
8
10
12
14
16

ECO:LOGIC ENGINEERING
CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 4-3
BUILDOUT WATER SYSTEM WITH EXISTING DEFICIENCIES

Distribution System

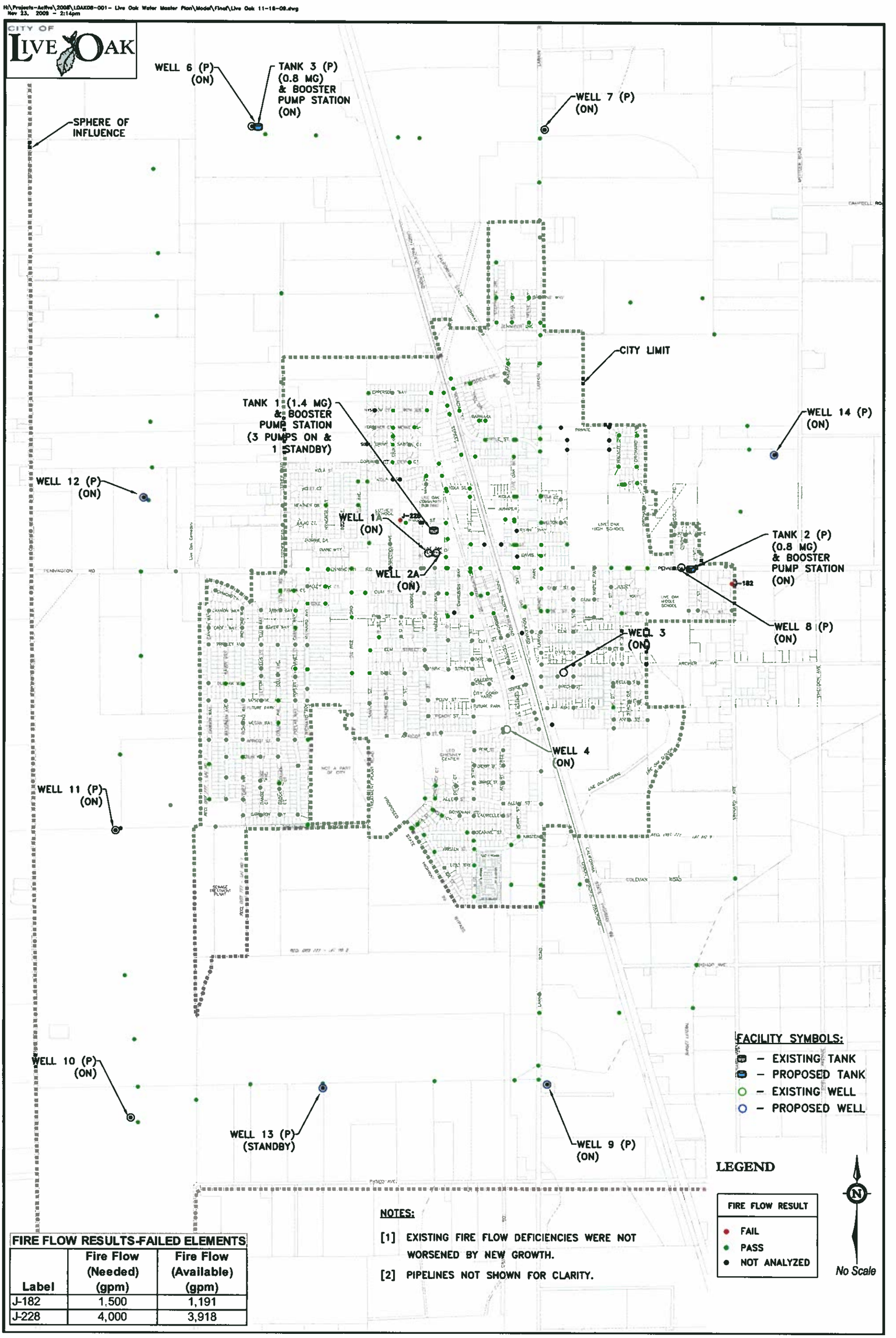
Planning level layout of the proposed water system was developed based on the results of the hydraulic modeling which accounts for the location of both water demands and supplies. Generally, water mains were located in future road right-of-ways as shown in the "Land Use Diagram" figure prepared by EDAW AECOM in 2009.

The intent of the proposed plan provided herein is to provide a conceptual layout of the facilities. Modifications to the proposed layout, such as altering the alignments to coincide with roadways, property lines, etc. are anticipated as specific improvement plans are developed and submitted for the City's review. Detailed engineering studies specific to the project will be necessary, along with environmental review and development of plans and specifications prior to construction. The new pipelines shown represent equivalent capacity. More pipes of a smaller diameter may be constructed if they meet the equivalent capacity shown in the master plan.

The new pipelines interconnect with existing pipelines to create additional looping within the system as shown in Figure 4-3. Future wells, discussed below, will connect at various locations. The facilities identified in this scenario are for supplying future growth and did not include mitigation of existing system deficiencies. The facilities identified to supply future growth were sized to not make any existing problems worse. The fire flow for build-out with existing deficiencies analysis is shown on Figure 4-4. A secondary benefit of the additional looping developed as part of the build-out system included mitigation of several fire flow deficiencies associated with the existing system.

The proposed improvements as envisioned at build-out will meet the design criteria; however, the system will be constructed incrementally as development progresses and additional evaluations will need to be performed to size pipelines such that all design conditions are satisfied during the incremental expansion of the system. The result of the incremental evaluations should also conform with the build-out infrastructure requirements.

As an example if a project were to be approved in the southern portion of the SOI, far away from existing sources of supply, the fire flow condition may not be met, even though the system has ample source capacity at the time of the development. In this case, the project proponent should be required to construct a new well in the vicinity, or if necessary a tank and pump station. These requirements would be discovered during the design and design review process.



NOTES:

[1] EXISTING FIRE FLOW DEFICIENCIES WERE NOT WORSENED BY NEW GROWTH.

[2] PIPELINES NOT SHOWN FOR CLARITY.

FIRE FLOW RESULTS-FAILED ELEMENTS

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)
J-182	1,500	1,191
J-228	4,000	3,918

ECO:LOGIC ENGINEERING
CITY OF LIVE OAK - WATER MASTER PLAN

FIGURE 4-4
FIRE FLOW ANALYSIS
BUILDOUT WATER SYSTEM WITH EXISTING DEFICIENCIES

Estimated Capital Costs – Build-out

The opinion of probable cost for the identified water infrastructure improvements to supply future growth is summarized in Table 4-4. The location of the recommended future water infrastructure is shown on Figure 4-3. The estimates are based on planning level analysis and do not include site specific conditions, therefore a 20 percent contingency is included. Soft costs also represent a significant portion of capital improvement projects and include design, administration/legal and construction inspection and are estimated to be 20 percent of the total construction costs.

Table 4-4
Proposed Improvements Opinions of Probable Cost For New Users [a]

ID	Description	Qty.	Unit	Unit Cost	Total Cost
Supply					
	Tank	700,000	Gallons	$1	$700,000
	Tank	700,000	Gallons	$1	$700,000
	Booster Pump Station	230	Horsepower	$1,180,000	$1,180,000
	Booster Pump Station	230	Horsepower	$1,180,000	$1,180,000
	Wells with treatment	8	Each	$2,700,000	$21,600,000
				Subtotal	$25,360,000
Northwest					
a	14" water main - new	8,055	Length Feet	$140	$1,130,000
b	12" water main - new	4,235	Length Feet	$120	$510,000
c	10" water main - new	8,915	Length Feet	$100	$890,000
d	8" water main - new	1,670	Length Feet	$80	$130,000
e	12" water main - replacement	1,440	Length Feet	$144	$210,000
f	10" water main - replacement	1,970	Length Feet	$120	$240,000
g	8" water main - new	275	Length Feet	$80	$20,000
				Subtotal	$3,130,000
Southwest					
h	14" water main - new	14,810	Length Feet	$140	$2,070,000
i	8" water main - new	1,965	Length Feet	$80	$160,000
				Subtotal	$2,230,000
Southeast					
j	14" water main - new	1,025	Length Feet	$140	$140,000
k	12" water main - new	7,560	Length Feet	$120	$910,000
l	10" water main - new	1,685	Length Feet	$100	$170,000
m	10" water main - replacement	4,560	Length Feet	$120	$550,000
				Subtotal	$1,770,000

ID	Description	Qty.	Unit	Unit Cost	Total Cost
Northeast					
n	14" water main - replacement	570	Length Feet	$168	$100,000
o	12" water main - replacement	4,900	Length Feet	$120	$590,000
p	12" water main - new	9,245	Length Feet	$120	$1,110,000
				Subtotal	$1,800,000
				Construction Subtotal	**$34,290,000**
				Contingencies at 20%	$6,860,000
				Subtotal	**$41,150,000**
	Administration, Engineering @ 20%				$8,230,000
				Total	**$49,380,000**

(a) 20 Cities ENRCCI = 8,578 June 2009.

Chapter 5

Proposed Connection Fee

Capacity improvements and associated capital costs have been identified in previous Chapters of this master plan. Facilities financed with connection fees include backbone facilities such as water supply, storage/pumping and distribution system improvements, which provide the necessary capacity to serve future growth. A recommended water connection fee to fund these improvements is developed in this chapter. Consistent with California law, the cost of future expansions should be assigned to future development and not existing users.

Specific onsite improvements within specific developments that are needed to provide service to the development include distribution system piping, services, blow offs, fire flows in excess of normal requirements, and other appurtenances. These improvements are financed by the developer, constructed to City standards and deeded to the City. These "onsite" improvements should be paid for by the developer and are not included or credited to the connection fees.

Depending on the nature of the improvements and the amount and timing of development, sufficient funds from connection fees may not fully fund the capacity expansions in the short-term. In such cases it is typical for developers to provide capacity in excess of their need with a reimbursement from the City as additional connections occur.

5.1 METHODOLOGY

Development of the connection fee must have a relationship to the cost of providing the service. California law and case history dictate that no user pay more than their fair share of the cost to provide public services. To simplify the process of determining the share of these costs for which an increment of future development is responsible, the concept of the Equivalent Dwelling Unit (EDU) will be used. An EDU represents the water demand in relation to the water demand for a single-family dwelling unit.

Multi-family residential, commercial and industrial demands can be represented as a multiple of EDUs depending on their relative demand. In this way, the demands from various land uses can be put in terms of EDUs to determine the appropriate connection fee.

This method is a common and simple means of determining the connection fee and still considers the relative demand that new service places on the system.

5.1.1 FORMULATION OF FEE

As noted above, the EDU will serve as the basis for the water connection fee. The actual connection fee is dependent on the capital cost of improvements needed to serve the

development. The typical single family home in Live Oak uses an average of 500 gpd (as described in Chapter 2). The recommended connection fee is calculated based on the capital cost estimate for the improvements required to provide service to a single EDU within the system. It should be pointed out that existing users are not expected, or legally bound, to pay for capital improvements needed to expand the water system to serve new users. Thus, the connection fee is based solely on the number of new EDUs served by a given increment of water system improvements.

The fee calculated in this analysis will be referred to as the 2009 Connection Fee and includes three components:

1) **System Buy-In**: The system buy-in charge based on the City's existing water infrastructure assets. The analysis estimates the total cost of all of the assets at installation less accumulated depreciation.

2) **Future CIP Project Costs**: The future CIP project costs are based on the projected facility needs as identified in the Water Master Plan. These costs were split between existing and future users based on benefit. The costs allocated to future users are included in the 2009 Water Connection Fee.

3) **Meter Installation Costs**: The cost of installing and connecting a water meter to the City's distribution system is also included in the 2009 Water Connection Fee.

Each of these fee components and how they were computed are discussed in greater detail in Appendix **B**.

Residential Connection fee

The connection fee will vary depending on the type of development (e.g. single family, duplex, multi-unit, etc.) and the demand on the system. Table 5-1 includes a summary of the various types of residential development. Recommended connection fees are included for single-family dwellings. There is significant variation in the type of multi-family and apartment buildings, and their associated water demands. Due to the lack of accurate meter reading data for these units, average water demand ranges within the City cannot be established. The usage rate depends on the number of units, landscaping, and amenities (e.g. pool, spa and landscaping). Connection fees for multi-family and apartments should be based on the meter size and usage as discussed in the following section.

Table 5-1
Summary of Residential Connection Fee

Water User	Equivalent Dwelling Units (EDUs)	Annual Average Water Demand Factor, gpd/connection	Connection Fee
Single-Family Home	1.0	500	$7,398
Multi-unit Housing	Varies	Varies[(a)]	Site specific
Large Apartment	Varies	Varies[(a)]	Site specific

(a) Demand factor can vary. Connection fee should be based on site-specific conditions related to demands.

Non-Residential/Multi-Unit/Apartment Connection Fee

Non-residential, multi-unit, and apartment connection fees are discussed in this section. Historically the connection fees have been calculated using the meter size as determined by the meter equivalence ratio. This method can result in a connection fee that is too high or low in the larger meter sizes. A discussion of meter ratios and the recommended connection fee based on demand follows.

The size of the meter required to provide flows desired by the user can be used to determine the connection fee based on the meter equivalence ratio. Meter equivalent ratios are a common means of scaling connection fees and are based on the maximum capacity of the meter.

The meter equivalence ratio is typically calculated based on the maximum capacity of a particular size of meter as determined by the American Water Works Association (AWWA) standards. Table 5-2 includes a summary of the meter ratios through a 6-inch meter. The table includes meter ratios used by the AWWA standard and the proposed equivalence ratio determined and recommend as the basis moving forward.

Table 5-2
Meter Equivalence Ratios

Meter Size, in	Meter Ratio		Meter Capacity (gpm)[c]
	AWWA[a]	Proposed[b]	
5/8	1	n/a	20
3/4	1.5	1	30
1	2.5	1.7	50
1.5	5	3.3	100
2	8	5.3	160
3	17.5	11.7	350
4	31.5	21.0	630
6	70	46.7	1,400

(a) American Water Works Association (AWWA) meter ratio calculation based on a 5/8-inch meter.
(b) Proposed meter ratio based on ¾-inch meter as basis for ratio.
(c) Based on AWWA standards for maximum flow through meter.

The proposed meter equivalence ratio was revised from the AWWA standard because the City Standards state that the minimum meter size is a ¾-inch meter. AWWA bases the meter equivalence ratios on a 5/8-inch meter; however, for our calculations the smallest meter used is a ¾-inch meter so the proposed equivalences are based on a ¾-inch meter capacity as a reference.

Basing the connection fee on the meter size works well with smaller meters up to 1-inch. The demand placed on the system by larger meters could be excessive, especially if onsite storage were provided to equalize peaks. As an example, a 2-inch service could place a demand of 230,000 gpd (160 gpm x 1440 min) on the system, which is the equivalent of 460 single-family

homes (requiring a $3.4 million connection fee based on an EDU basis). As the meter gets larger, this discrepancy increases.

Connection fees for non-residential service connections are presented in Table 5-3 based on the revised meter ratios. Connection fees for meters 1.5-inch and greater should be calculated on a site-specific basis; however, the minimum recommended connection fee for 1.5- through 5-inch meters is included in Table 5-3.

Table 5-3
Non-Residential Water Service Connection Fee

Meter Size	Based on Revised Meter Ratios[b]
5/8	n/a
3/4	$7,398
1	$11,370
1.5 [a]	$21,399
2 [a]	$33,394
3 [a]	$72,543
4 [a]	$129,887
6 [a]	$283,290

(a) Minimum recommended connection fee; to be determined on a site-specific basis.

(b) Revised meter ratio based on ¾ meter as standard.

Summary of Proposed Water Connection fee

The proposed water service fees for residential and non-residential water connections are included in Table 5-4. The connection fees are considered based on demands for the particular non-residential service. Connection fees for metered services larger than 1.5-inches should determined on a site-specific basis.

Table 5-4
Summary of Recommended Water Connection Fees

Service Type	Connection Fee
Residential Connection Fees	
Single Family	$7,398
Multi-Unit and Apartments	Site Specific
Non-Residential Connection Fee	
Meter Size, in	Connection Fee
5/8	n/a
3/4	$7,398
1	$11,370
Meter Size, in	Min. Connection Fee [(a)]
1.5	$21,399
2	$33,394
3	$72,543
4	$129,887
6	$283,290

(a) Recommended minimum connection fee; to be considered on site-specific conditions.

5.1.2 INDEXING OF FEES

Indexing is used to provide for automatic adjustment of fees to account for inflationary cost increase. An enabling ordinance can provide for automatic fee adjustment on a prescribed date each year, or every other year or third year, etc. Annual indexing revisions are recommended to minimize the magnitude of the change and insure that revenue more closely follows expenses. One approach involves adjustment based on an accepted cost indicator such as the CPI (Consumer Price Index). The latter is preferred since it more closely reflects costs in the construction industry, which are used as the basis for computing connection fees. This approach provides the most accurate adjustment, although the incremental change (increase or decrease) is not known beyond the current year.

Appendix A

Hydraulic Modeling Result

Existing Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-1	77.1	8.37	73.5	247.0
J-2	76.8	5.28	73.9	247.5
J-3	76.5	10.13	74.0	247.5
J-4	76.8	2.98	74.1	247.9
J-5	77.7	6.23	73.2	247.0
J-6	77.8	24.71	73.2	247.1
J-7	77.0	27.75	73.9	247.8
J-8	76.5	16.84	74.1	247.8
J-9	76.5	9.53	74.1	247.8
J-10	76.6	3.49	74.0	247.7
J-11	76.8	15.21	74.0	247.9
J-12	76.6	0.95	74.7	249.3
J-13	76.3	13.83	74.2	247.9
J-14	76.0	0.00	74.3	247.6
J-15	76.0	2.80	74.2	247.6
J-16	75.9	16.23	74.3	247.8
J-17	75.9	5.91	74.2	247.4
J-18	76.0	17.08	74.0	247.0
J-19	75.9	8.32	73.9	246.7
J-20	75.9	2.37	73.9	246.7
J-21	75.8	9.90	74.0	246.7
J-22	75.7	6.89	74.0	246.8
J-23	75.7	6.78	74.0	246.8
J-24	75.7	22.41	74.0	246.8
J-25	75.8	17.98	74.0	246.7
J-26	75.5	18.14	74.2	247.0
J-27	75.6	14.79	74.2	247.0
J-28	75.6	11.06	74.2	247.1
J-29	75.6	11.70	74.1	246.9
J-30	75.5	14.76	74.4	247.5
J-31	75.4	12.96	74.4	247.4
J-32	75.5	7.31	74.4	247.4
J-33	75.3	3.65	74.5	247.6
J-34	75.2	1.37	74.6	247.7
J-35	75.1	7.23	74.7	247.8
J-36	75.1	5.26	74.9	248.1
J-37	75.2	3.12	74.8	248.1
J-38	75.3	8.26	74.7	248.0
J-39	75.3	10.48	74.7	248.0
J-40	75.3	13.22	74.6	247.7
J-41	75.4	6.63	74.7	248.0
J-42	75.3	6.76	74.8	248.1
J-43	75.3	6.92	74.8	248.2
J-44	75.2	11.36	74.9	248.4
J-45	75.2	5.28	74.9	248.4
J-46	75.1	5.20	75.0	248.5
J-47	75.1	3.09	75.0	248.4
J-48	75.1	6.81	74.9	248.2

Existing Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-49	75.0	3.75	74.9	248.2
J-50	75.1	11.43	74.9	248.3
J-51	75.0	4.30	74.9	248.2
J-52	75.0	2.85	75.0	248.4
J-53	75.0	6.84	75.1	248.5
J-54	75.0	0.95	75.1	248.6
J-55	75.0	3.59	75.1	248.6
J-56	74.7	16.21	75.2	248.6
J-57	74.5	9.98	75.3	248.5
J-58	74.5	17.01	75.2	248.4
J-59	74.5	19.24	75.2	248.2
J-60	74.9	16.37	75.0	248.2
J-61	74.8	21.65	75.0	248.1
J-62	74.3	9.16	75.2	248.1
J-63	74.2	13.49	75.2	248.1
J-64	74.5	22.55	75.1	248.1
J-65	74.7	4.07	75.0	248.0
J-66	74.4	8.87	75.1	248.0
J-67	74.4	2.30	75.1	248.0
J-68	74.0	6.31	75.3	248.0
J-69	74.0	5.28	75.3	248.0
J-70	74.0	10.66	75.3	248.0
J-71	74.0	6.50	75.3	248.0
J-72	74.0	8.18	75.3	248.1
J-73	74.0	7.92	75.3	248.1
J-74	74.1	8.35	75.3	248.1
J-75	74.0	6.76	75.3	248.1
J-76	74.1	10.88	75.3	248.2
J-77	74.0	10.58	75.3	248.0
J-78	74.1	14.91	75.4	248.4
J-79	74.2	13.44	75.4	248.5
J-80	74.2	9.06	75.5	248.8
J-81	74.0	18.45	75.8	249.2
J-82	74.0	9.59	75.9	249.4
J-83	74.0	5.73	75.9	249.4
J-84	74.5	14.42	75.7	249.4
J-85	74.6	10.29	75.7	249.5
J-86	75.0	5.15	75.5	249.4
J-87	75.0	6.44	76.0	250.6
J-88	75.0	8.58	75.4	249.3
J-89	75.0	8.61	74.3	246.8
J-90	75.3	6.36	76.0	251.0
J-91	75.0	7.55	76.1	250.9
J-92	75.0	16.71	76.6	252.0
J-93	74.9	12.38	76.7	252.3
J-94	75.0	13.73	76.9	252.6
J-95	75.1	10.88	77.6	254.4
J-96	75.2	5.23	78.7	257.0

Existing Water System - City of Live Oak
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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-97	75.2	23.68	78.3	256.3
J-98	75.3	16.95	77.1	253.5
J-99	75.3	12.43	77.3	254.0
J-100	75.2	13.86	77.5	254.3
J-101	75.4	16.23	77.0	253.5
J-102	75.7	11.96	75.6	250.6
J-103	75.8	14.20	75.5	250.4
J-104	75.8	16.76	75.5	250.4
J-105	76.0	9.95	75.3	250.1
J-106	76.0	5.31	75.3	250.1
J-107	76.2	5.17	75.1	249.8
J-108	76.3	4.91	75.0	249.7
J-109	76.0	9.98	75.2	249.8
J-110	76.1	8.40	75.2	249.8
J-111	75.9	9.08	75.4	250.1
J-112	75.9	3.27	75.6	250.6
J-113	75.7	5.17	75.7	250.6
J-114	75.6	16.08	75.7	250.6
J-115	75.8	3.24	75.6	250.6
J-116	75.6	7.12	75.7	250.6
J-117	75.6	5.15	75.7	250.6
J-118	75.6	7.37	75.7	250.6
J-119	76.1	7.79	74.3	247.8
J-120	76.7	6.86	74.5	248.9
J-121	75.6	8.80	75.8	250.9
J-122	75.7	4.86	74.6	248.1
J-123	75.7	7.68	74.7	248.3
J-124	75.6	5.31	74.9	248.7
J-125	75.5	0.66	74.9	248.8
J-126	75.5	1.43	74.9	248.7
J-127	75.4	2.56	74.6	247.8
J-128	75.4	1.10	75.2	249.3
J-129	75.4	5.04	75.2	249.3
J-130	75.3	7.63	74.6	247.7
J-131	75.4	27.06	74.5	247.6
J-132	75.3	6.10	74.6	247.7
J-133	75.2	5.52	74.7	247.8
J-134	75.3	11.62	74.5	247.5
J-135	75.4	21.99	74.4	247.3
J-136	75.6	11.14	74.1	246.8
J-137	75.3	7.57	74.6	247.7
J-138	75.0	2.06	74.7	247.8
J-139	75.1	0.56	74.7	247.8
J-140	75.1	13.13	74.8	248.0
J-141	75.0	3.72	77.1	253.2
J-142	74.8	10.35	77.3	253.4
J-143	74.5	14.01	77.3	253.3
J-144	74.8	7.26	76.8	252.2

Existing Water System - City of Live Oak
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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-145	74.7	4.94	76.6	251.7
J-146	74.3	16.82	76.9	252.1
J-147	74.5	15.66	75.9	250.0
J-148	74.5	10.12	75.9	250.0
J-149	74.2	15.13	75.9	249.6
J-150	74.1	13.13	75.8	249.3
J-151	74.0	17.85	76.0	249.6
J-152	74.0	11.90	75.9	249.4
J-153	74.5	9.00	75.3	248.6
J-154	74.0	14.65	75.3	248.0
J-155	74.0	2.14	75.3	248.0
J-156	74.0	4.38	75.3	248.0
J-157	75.3	6.97	74.8	248.1
J-158	75.1	5.73	74.9	248.1
J-159	75.0	9.34	74.9	248.1
J-160	75.5	6.07	74.3	247.3
J-161	75.5	5.70	74.6	247.8
J-162	75.5	5.12	74.5	247.6
J-163	75.4	8.26	74.5	247.6
J-164	75.2	10.13	74.6	247.6
J-165	75.2	3.09	75.4	249.5
J-166	75.2	3.54	75.5	249.8
J-167	75.2	5.07	78.2	256.0
J-168	75.1	5.36	78.5	256.6
J-169	75.1	1.95	78.6	256.8
J-170	74.9	1.72	80.4	260.7
J-171	75.1	6.60	79.5	258.8
J-172	75.0	11.70	80.3	260.7
J-173	75.3	9.56	77.6	254.7
J-174	75.4	5.81	77.6	254.7
J-175	75.4	24.13	74.4	247.4
J-176	75.4	9.76	74.5	247.6
J-177	75.6	5.23	74.4	247.5
J-178	75.6	12.83	74.3	247.4
J-179	76.0	10.69	73.8	246.7
J-180	76.0	2.61	73.8	246.7
J-181	76.0	0.00	73.8	246.7
J-182	76.0	0.00	73.8	246.7
J-183	75.8	7.11	73.9	246.7
J-184	75.8	0.74	73.9	246.7
J-185	75.8	0.71	73.9	246.7
J-186	75.8	1.06	73.9	246.7
J-187	75.7	1.43	74.0	246.7
J-188	75.9	16.03	73.9	246.7
J-189	75.9	22.25	73.9	246.7
J-190	74.8	9.90	76.7	252.2
J-191	74.8	11.25	76.3	251.2
J-192	74.8	13.07	76.3	251.2

Existing Water System - City of Live Oak
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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-193	75.0	5.81	75.3	248.9
J-194	74.7	5.57	76.0	250.4
J-195	74.9	11.83	76.0	250.6
J-196	74.3	10.56	75.9	249.7
J-197	74.6	7.60	76.0	250.4
J-198	74.8	6.05	77.6	254.1
J-199	75.0	7.18	77.6	254.4
J-200	74.9	6.36	78.1	255.5
J-201	75.1	2.33	78.0	255.3
J-202	75.0	6.36	77.6	254.3
J-203	74.8	2.87	78.5	256.2
J-204	75.0	5.46	74.2	246.5
J-205	75.0	6.58	75.4	249.3
J-206	75.3	5.41	74.8	248.1
J-207	75.1	5.76	74.9	248.1
J-208	75.0	4.86	74.9	248.1
J-209	75.1	7.87	75.0	248.5
J-210	75.0	11.67	77.1	253.2
J-211	75.2	2.45	76.3	251.6
J-212	75.3	7.79	74.5	247.6
J-213	75.8	2.59	73.9	246.7
J-215	75.9	28.46	73.9	246.7
J-216	75.7	23.55	74.0	246.8
J-217	76.0	5.34	74.1	247.2
J-218	76.9	14.89	73.8	247.5
J-219	75.5	4.86	74.6	247.9
J-220	75.3	2.14	74.6	247.7
J-221	75.2	9.27	74.6	247.7
J-222	75.1	12.38	74.9	248.3
J-223	74.3	3.65	75.1	248.0
J-224	74.0	3.30	75.3	248.0
J-225	75.2	3.57	74.3	247.0
J-226	75.2	15.33	79.7	259.4
J-227	75.6	11.36	76.4	252.2
J-228	75.6	23.47	76.1	251.5
J-229	75.2	3.66	77.9	255.3
J-230	75.1	6.68	74.7	247.8
J-231	74.7	9.03	77.6	254.1
J-232	75.0	2.96	80.6	261.1
J-233	76.6	4.20	74.7	249.2
J-234	75.6	9.40	74.1	246.8
J-235	74.5	9.06	75.3	248.6
J-236	76.0	5.09	74.3	247.7
J-237	75.1	0.00	81.4	263.2
J-238	75.1	12.77	75.4	249.4
J-245	75.3	7.26	74.6	247.7
J-246	75.2	11.64	76.9	252.9
J-247	74.8	7.50	76.7	252.0

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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-248	74.7	12.99	76.8	252.3
J-249	75.0	6.21	78.0	255.3
J-250	75.8	6.31	73.9	246.7
J-251	75.7	10.19	74.0	246.7
J-252	75.3	7.60	74.8	248.1
J-253	75.2	5.76	74.6	247.7
J-254	75.2	4.41	74.3	246.9
J-255	75.2	7.42	74.3	246.9
J-256	75.1	4.73	74.3	246.8
J-257	75.1	11.06	74.3	246.8
J-258	75.5	32.08	74.3	247.2
J-259	74.3	8.53	75.2	248.0
J-260	75.1	0.00	74.3	246.8
J-261	75.0	9.48	74.2	246.6
J-262	75.1	7.08	74.2	246.6
J-263	75.0	8.97	74.2	246.4
J-264	75.0	8.21	74.2	246.4
J-265	74.8	9.06	74.2	246.3
J-266	74.7	7.26	74.2	246.3
J-267	74.8	11.78	74.2	246.3
J-268	74.8	12.25	74.2	246.2
J-269	74.5	16.00	74.3	246.2
J-270	74.3	34.71	74.4	246.2
J-271	74.3	10.21	74.3	246.2
J-272	74.7	9.11	74.2	246.2
J-273	74.9	13.57	74.1	246.2
J-274	75.0	9.90	74.0	246.2
J-275	75.1	9.08	74.0	246.2
J-276	74.9	9.87	74.1	246.2
J-277	75.0	11.43	74.0	246.2
J-278	75.2	10.01	74.0	246.2
J-279	75.3	10.19	73.9	246.1
J-280	74.6	10.80	74.3	246.2
J-281	74.4	13.67	74.3	246.2
J-282	74.5	11.27	74.3	246.2
J-283	74.2	43.45	74.4	246.2
J-284	75.0	35.61	74.0	246.1
J-285	75.0	1.90	74.1	246.3
J-286	75.0	9.59	74.1	246.2
J-287	75.0	5.79	74.1	246.3
J-288	75.0	6.81	74.1	246.3
J-289	75.0	5.49	74.2	246.4
J-290	75.0	8.18	74.2	246.4
J-291	75.1	5.43	74.1	246.4
J-292	74.5	7.31	74.3	246.2
J-293	75.0	9.61	74.3	246.6
J-294	74.0	5.01	75.3	248.0
J-295	74.0	11.70	75.3	248.0

Existing Water System - City of Live Oak
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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-296	73.7	16.98	75.4	248.0
J-297	73.5	24.66	75.5	248.0
J-298	73.6	12.91	75.4	248.0
J-299	73.8	7.82	75.4	248.0
J-300	73.8	5.62	75.4	248.0
J-301	74.0	4.67	75.3	248.0
J-302	74.0	10.13	75.3	248.0
J-303	76.4	5.01	74.9	249.7
J-304	76.7	9.37	74.8	249.5
J-305	76.9	12.51	74.6	249.5
J-306	76.6	8.42	74.7	249.4
J-307	76.4	8.58	74.9	249.5
J-308	76.4	9.67	74.9	249.5
J-309	76.2	8.47	75.0	249.7
J-310	76.3	12.09	75.0	249.6
J-311	76.5	8.50	74.9	249.5
J-312	78.0	1.13	73.1	247.0
J-313	78.5	1.35	72.9	247.0
J-314	78.1	17.85	73.1	247.0
J-315	78.1	28.04	73.1	247.0
J-316	78.2	11.70	73.0	247.0
J-317	78.9	11.88	72.7	247.0
J-318	78.7	8.18	72.8	247.0
J-319	78.5	7.31	72.9	247.0
J-320	79.5	10.40	72.5	247.0
J-321	75.5	10.03	77.0	253.5
J-322	73.7	3.09	74.0	244.8
J-323	73.0	206.53	73.7	243.4
J-324	76.6	0.74	74.7	249.3
J-325	76.0	0.00	73.8	246.7
J-326	74.2	0.00	74.4	246.2
J-327	74.3	0.00	74.4	246.2
J-328	74.9	0.00	74.1	246.2
J-329	74.8	0.00	74.1	246.2
J-330	74.7	0.00	74.2	246.2
J-331	74.5	0.00	74.3	246.2
J-332	74.5	0.00	74.3	246.2
J-333	74.3	0.00	74.4	246.2
J-334	73.9	0.00	74.5	246.2
J-335	74.0	0.00	74.5	246.2
J-336	74.3	0.00	74.4	246.2
J-337	75.0	0.00	74.0	246.1
J-338	73.8	0.00	74.6	246.2
J-341	76.2	11.83	75.2	249.9
J-342	75.7	33.05	74.0	246.7
J-343	75.0	11.45	75.5	249.4
J-344	74.2	10.09	75.9	249.6
J-345	74.6	15.33	75.7	249.5

Existing Water System - City of Live Oak
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Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-346	74.8	11.06	74.2	246.2
J-347	74.6	0.00	74.2	246.2
J-348	73.9	0.00	74.5	246.2
J-349	73.9	0.00	74.5	246.2
J-350	73.8	0.00	74.6	246.2
J-351	74.2	0.00	74.4	246.2
J-352	74.4	0.00	74.3	246.2
J-356	74.2	0.00	74.4	246.2

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-1	8	184	120	0.4	0.00
P-2	8	323	120	0.7	0.00
P-3	8	265	120	0.9	0.00
P-4	8	339	120	0.0	0.00
P-5	8	245	120	0.3	0.00
P-6	8	460	120	0.0	0.00
P-7	8	325	120	0.3	0.00
P-8	8	155	120	0.0	0.00
P-9	6	285	120	0.1	0.00
P-10	6	235	120	0.3	0.00
P-11	8	258	120	0.5	0.00
P-12	8	280	120	0.1	0.00
P-13	8	474	120	0.8	0.00
P-14	8	368	120	0.4	0.00
P-15	8	307	120	0.1	0.00
P-16	2	374	120	0.6	0.00
P-17	6	135	120	1.1	0.00
P-18	8	491	120	0.3	0.00
P-19	6	313	120	0.4	0.00
P-20	6	299	120	0.6	0.00
P-21	6	402	120	0.5	0.00
P-22	6	99	120	0.1	0.00
P-23	6	140	120	0.1	0.00
P-24	8	613	120	0.6	0.00
P-25	8	493	120	0.4	0.00
P-26	6	564	120	2.2	0.00
P-27	6	400	120	2.4	0.00
P-28	6	398	120	1.9	0.00
P-29	6	401	120	1.4	0.00
P-30	6	190	120	0.1	0.00
P-31	6	229	120	0.1	0.00
P-32	8	447	120	0.0	0.00
P-33	6	200	120	0.2	0.00
P-34	6	89	120	0.1	0.00
P-35	8	371	120	0.2	0.00
P-36	8	242	120	0.1	0.00
P-37	6	220	120	0.1	0.00
P-38	6	496	120	0.2	0.00
P-39	8	282	120	1.0	0.00
P-40	8	259	120	0.7	0.00
P-41	8	100	120	0.2	0.00
P-42	6	196	120	0.1	0.00
P-43	8	642	120	0.0	0.00
P-44	6	258	120	0.1	0.00
P-45	8	171	120	0.0	0.00
P-46	8	171	120	0.1	0.00
P-47	6	220	120	0.1	0.00
P-48	6	747	120	0.6	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-49	6	500	120	0.3	0.00
P-50	4	163	120	0.1	0.00
P-51	8	110	120	0.0	0.00
P-52	6	369	120	0.6	0.00
P-53	8	269	120	1.3	0.00
P-54	8	269	120	1.2	0.00
P-55	8	131	120	1.0	0.00
P-56	6	142	120	0.4	0.00
P-57	8	681	120	0.4	0.00
P-58	6	400	120	0.3	0.00
P-59	6	99	120	0.4	0.00
P-60	4	153	120	0.2	0.00
P-61	6	356	120	2.2	0.00
P-62	8	360	120	1.3	0.00
P-63	8	346	120	1.1	0.00
P-64	6	255	120	0.2	0.00
P-65	6	320	120	0.7	0.00
P-66	6	285	120	0.5	0.00
P-67	8	111	120	0.3	0.00
P-68	6	129	120	2.5	0.01
P-69	6	292	120	0.5	0.00
P-70	6	636	120	0.2	0.00
P-71	6	403	120	0.3	0.00
P-72	6	377	120	0.4	0.00
P-73	6	197	120	0.1	0.00
P-74	6	207	120	0.1	0.00
P-75	8	496	120	0.2	0.00
P-76	6	669	120	0.1	0.00
P-77	8	484	120	0.0	0.00
P-78	8	135	120	0.0	0.00
P-79	6	136	120	0.0	0.00
P-80	6	186	120	0.4	0.00
P-81	6	289	120	0.7	0.00
P-82	6	236	120	1.0	0.00
P-83	6	274	120	0.8	0.00
P-84	6	273	120	1.2	0.00
P-85	6	564	120	0.3	0.00
P-86	6	297	120	0.1	0.00
P-87	10	365	120	0.2	0.00
P-88	8	241	120	0.2	0.00
P-89	8	413	120	0.1	0.00
P-90	8	112	120	1.5	0.00
P-91	8	396	120	0.1	0.00
P-92	8	283	120	0.0	0.00
P-93	6	504	120	0.2	0.00
P-94	6	506	120	0.5	0.00
P-95	6	161	120	0.8	0.00
P-96	6	182	120	0.8	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-97	6	317	120	0.9	0.00
P-98	6	324	120	0.5	0.00
P-99	8	191	120	0.6	0.00
P-100	8	169	120	0.7	0.00
P-101	8	344	120	0.7	0.00
P-102	8	398	120	0.5	0.00
P-103	6	190	120	1.1	0.00
P-104	8	437	120	0.0	0.00
P-105	6	326	120	0.2	0.00
P-106	8	184	120	0.8	0.00
P-107	6	319	120	1.0	0.00
P-108	6	322	120	0.5	0.00
P-109	6	172	120	0.7	0.00
P-110	6	174	120	0.1	0.00
P-111	6	312	120	0.3	0.00
P-112	8	450	120	0.1	0.00
P-113	6	151	120	0.1	0.00
P-114	8	177	120	0.2	0.00
P-115	6	341	120	0.2	0.00
P-116	2	260	120	0.3	0.00
P-117	6	158	120	0.5	0.00
P-118	6	421	120	0.0	0.00
P-119	2	606	120	0.9	0.00
P-120	6	351	120	1.3	0.00
P-121	6	181	120	0.2	0.00
P-122	6	218	120	0.7	0.00
P-123	6	525	120	0.7	0.00
P-124	6	613	120	0.9	0.00
P-125	6	294	120	0.2	0.00
P-126	6	275	120	0.1	0.00
P-127	6	485	120	0.5	0.00
P-128	4	303	120	0.6	0.00
P-129	6	128	120	0.2	0.00
P-130	8	595	120	0.0	0.00
P-131	8	124	120	0.3	0.00
P-132	8	254	120	0.3	0.00
P-133	8	260	120	0.3	0.00
P-134	8	275	120	0.4	0.00
P-135	8	233	120	1.0	0.00
P-136	8	271	120	0.9	0.00
P-137	8	274	120	1.3	0.00
P-138	8	239	120	1.7	0.00
P-139	8	249	120	1.5	0.00
P-140	8	258	120	1.5	0.00
P-141	6	228	120	3.0	0.01
P-142	6	149	120	2.0	0.00
P-143	8	367	120	2.1	0.00
P-144	8	367	120	3.1	0.01

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-145	8	728	120	3.0	0.01
P-146	8	131	120	1.8	0.00
P-147	8	448	120	0.0	0.00
P-148	6	252	120	0.4	0.00
P-149	8	129	120	0.0	0.00
P-150	8	449	120	2.1	0.00
P-151	8	367	120	1.9	0.00
P-152	8	353	120	3.2	0.01
P-153	8	386	120	4.7	0.01
P-154	6	693	120	0.5	0.00
P-155	8	441	120	0.2	0.00
P-156	6	412	120	0.4	0.00
P-157	6	277	120	0.5	0.00
P-158	6	257	120	1.1	0.00
P-159	6	337	120	0.9	0.00
P-160	6	488	120	0.7	0.00
P-161	6	352	120	2.4	0.00
P-162	8	169	120	4.4	0.01
P-163	6	599	120	2.2	0.00
P-164	6	692	120	0.1	0.00
P-165	6	270	120	0.4	0.00
P-166	6	241	120	1.0	0.00
P-167	6	486	120	1.3	0.00
P-168	8	250	120	1.1	0.00
P-169	6	513	120	2.2	0.00
P-170	6	361	120	2.4	0.00
P-171	6	379	120	2.9	0.01
P-172	6	701	120	1.9	0.00
P-173	8	552	120	0.8	0.00
P-174	8	273	120	0.9	0.00
P-175	6	256	120	0.1	0.00
P-176	8	400	120	0.1	0.00
P-177	6	274	120	0.1	0.00
P-178	6	292	120	0.0	0.00
P-179	8	512	120	0.1	0.00
P-180	4	343	120	0.1	0.00
P-181	2	484	120	0.5	0.00
P-182	6	155	120	0.2	0.00
P-183	6	353	120	1.8	0.00
P-184	6	670	120	1.3	0.00
P-185	8	160	120	1.8	0.00
P-186	6	130	120	0.8	0.00
P-187	8	190	120	0.0	0.00
P-188	6	521	120	1.7	0.00
P-189	10	170	120	0.6	0.00
P-190	6	231	120	3.1	0.01
P-191	6	92	120	3.0	0.01
P-192	8	623	120	1.5	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-193	6	368	120	0.2	0.00
P-194	8	757	120	0.9	0.00
P-195	6	244	120	0.2	0.00
P-196	6	185	120	1.4	0.00
P-197	6	211	120	0.9	0.00
P-198	8	268	120	0.7	0.00
P-199	8	749	120	2.3	0.00
P-200	6	344	120	0.0	0.00
P-201	2	876	120	0.4	0.00
P-202	6	435	120	0.7	0.00
P-203	8	130	120	0.0	0.00
P-204	8	303	120	1.4	0.00
P-205	6	287	120	2.2	0.00
P-206	8	275	120	0.8	0.00
P-208	6	16	120	1.3	0.00
P-209	8	49	120	1.1	0.00
P-210	8	136	120	0.0	0.00
P-211	6	338	120	0.1	0.00
P-212	6	25	120	0.1	0.00
P-213	6	455	120	0.0	0.00
P-214	6	176	120	1.0	0.00
P-215	6	980	120	0.0	0.00
P-216	8	886	120	0.3	0.00
P-217	8	153	120	0.1	0.00
P-218	6	685	120	2.1	0.00
P-219	6	373	120	1.4	0.00
P-220	6	38	120	2.2	0.00
P-221	6	321	120	0.0	0.00
P-222	6	55	120	1.0	0.00
P-223	6	516	120	0.8	0.00
P-224	6	193	120	1.0	0.00
P-225	8	853	120	1.7	0.00
P-226	4	25	120	3.0	0.01
P-227	4	363	120	3.3	0.01
P-228	6	42	120	4.9	0.02
P-229	6	469	120	2.7	0.01
P-230	6	382	120	1.4	0.00
P-231	6	366	120	1.3	0.00
P-232	6	450	120	0.8	0.00
P-233	8	842	120	0.0	0.00
P-234	8	209	120	0.3	0.00
P-235	8	40	120	0.0	0.00
P-236	6	239	120	0.8	0.00
P-237	6	154	120	0.9	0.00
P-238	6	57	120	2.5	0.01
P-239	6	524	120	3.9	0.01
P-240	8	156	120	3.0	0.01
P-241	8	53	120	2.5	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-242	6	352	120	1.1	0.00
P-243	6	361	120	1.2	0.00
P-244	6	29	120	1.2	0.00
P-245	6	142	120	0.0	0.00
P-246	8	268	120	0.1	0.00
P-247	6	331	120	2.5	0.01
P-248	6	370	120	1.0	0.00
P-249	6	315	120	1.9	0.00
P-250	6	96	120	0.1	0.00
P-251	6	457	120	0.8	0.00
P-252	6	14	120	2.2	0.00
P-253	8	686	120	0.3	0.00
P-254	6	477	120	0.1	0.00
P-255	8	189	120	0.5	0.00
P-256	8	36	120	0.1	0.00
P-257	6	244	120	0.8	0.00
P-258	6	37	120	0.7	0.00
P-259	6	680	120	0.7	0.00
P-260	8	236	120	0.9	0.00
P-261	10	348	120	5.5	0.01
P-262	10	24	120	6.5	0.02
P-263	6	919	120	0.0	0.00
P-264	6	20	120	1.2	0.00
P-265	6	439	120	0.7	0.00
P-266	6	182	120	1.4	0.00
P-267	6	160	120	0.7	0.00
P-268	8	176	120	4.5	0.01
P-269	12	189	120	2.9	0.00
P-270	12	183	120	2.9	0.00
P-271	12	213	120	3.1	0.00
P-272	12	145	120	3.1	0.00
P-273	99	140	120	0.0	0.00
P-274	8	125	120	6.1	0.02
P-275	8	233	120	5.9	0.02
P-277	99	206	120	0.0	0.00
P-278	8	125	120	6.1	0.02
P-279	8	124	120	5.9	0.02
P-281	6	416	120	1.7	0.00
P-282	8	51	120	0.8	0.00
P-284	6	734	120	0.0	0.00
P-285	8	455	120	0.0	0.00
P-286	6	807	120	0.3	0.00
P-287	8	727	120	0.7	0.00
P-288	8	701	120	0.2	0.00
P-289	8	247	120	0.8	0.00
P-290	6	262	120	0.7	0.00
P-291	6	252	120	2.0	0.00
P-292	6	244	120	2.1	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-293	8	734	130	0.1	0.00
P-296	6	68	130	4.3	0.01
P-297	6	95	130	4.3	0.01
P-298	16	445	130	4.7	0.00
P-299	8	315	120	1.9	0.00
P-300	6	363	120	3.4	0.01
P-301	8	907	120	1.6	0.00
P-302	6	211	120	2.7	0.01
P-303	8	305	120	0.0	0.00
P-304	8	299	120	0.1	0.00
P-305	6	217	120	2.5	0.01
P-306	8	339	120	2.5	0.00
P-307	8	350	120	2.1	0.00
P-308	8	184	130	0.3	0.00
P-309	8	272	130	0.0	0.00
P-310	8	476	130	0.1	0.00
P-311	8	269	130	0.1	0.00
P-312	6	510	120	0.4	0.00
P-313	8	105	120	0.3	0.00
P-314	6	309	120	0.5	0.00
P-315	6	345	120	0.1	0.00
P-316	6	207	130	0.6	0.00
P-317	8	262	120	0.8	0.00
P-318	8	276	130	0.0	0.00
P-319	8	259	120	0.7	0.00
P-320	8	278	130	0.1	0.00
P-321	8	320	120	0.9	0.00
P-322	8	1,220	120	0.7	0.00
P-323	8	405	130	1.7	0.00
P-324	8	610	120	0.0	0.00
P-325	8	184	120	0.2	0.00
P-326	8	397	130	1.0	0.00
P-327	8	303	130	1.0	0.00
P-328	8	212	130	0.0	0.00
P-329	8	304	130	0.9	0.00
P-330	8	299	130	0.5	0.00
P-331	8	267	130	0.5	0.00
P-332	8	261	130	0.7	0.00
P-333	8	257	130	0.4	0.00
P-334	8	259	130	0.3	0.00
P-335	8	280	130	0.4	0.00
P-336	8	256	130	0.1	0.00
P-337	8	604	130	0.1	0.00
P-338	8	267	130	0.3	0.00
P-339	8	255	130	0.1	0.00
P-340	8	255	130	0.1	0.00
P-341	8	514	130	0.1	0.00
P-342	8	303	130	0.1	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-343	8	516	130	0.0	0.00
P-344	8	264	130	0.1	0.00
P-345	8	519	130	0.1	0.00
P-346	8	255	130	0.3	0.00
P-347	8	281	130	0.7	0.00
P-348	8	369	130	0.4	0.00
P-349	8	597	130	0.0	0.00
P-350	8	256	130	0.1	0.00
P-351	8	266	130	0.0	0.00
P-352	8	595	130	0.8	0.00
P-353	8	182	130	1.3	0.00
P-354	8	185	130	0.6	0.00
P-355	8	365	130	0.5	0.00
P-356	8	126	130	0.5	0.00
P-357	8	368	130	0.5	0.00
P-358	8	262	130	0.1	0.00
P-359	8	263	130	0.3	0.00
P-360	8	233	130	0.4	0.00
P-361	8	527	130	0.4	0.00
P-362	8	270	130	0.8	0.00
P-363	8	112	130	0.3	0.00
P-364	8	379	130	0.3	0.00
P-365	8	264	130	0.5	0.00
P-366	8	597	130	0.0	0.00
P-367	8	373	120	0.9	0.00
P-368	8	639	120	0.6	0.00
P-369	8	182	130	1.5	0.00
P-370	8	325	130	0.1	0.00
P-371	8	192	130	0.0	0.00
P-372	8	305	130	0.1	0.00
P-373	8	285	130	0.1	0.00
P-374	8	701	130	0.0	0.00
P-375	8	479	130	0.1	0.00
P-376	8	249	130	0.2	0.00
P-377	8	587	130	0.1	0.00
P-378	8	129	130	0.2	0.00
P-379	8	622	130	0.1	0.00
P-380	8	670	130	0.2	0.00
P-381	8	96	130	0.0	0.00
P-382	8	465	130	0.1	0.00
P-383	8	165	130	0.1	0.00
P-384	8	126	130	1.0	0.00
P-385	8	266	130	0.8	0.00
P-386	8	264	130	0.7	0.00
P-387	8	598	130	0.5	0.00
P-388	4	281	130	0.2	0.00
P-389	8	528	130	0.1	0.00
P-390	8	286	130	0.1	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-391	6	328	130	0.1	0.00
P-392	8	366	130	0.1	0.00
P-393	8	191	130	0.1	0.00
P-394	8	390	130	0.0	0.00
P-395	8	173	130	0.1	0.00
P-396	8	260	130	0.1	0.00
P-397	8	239	130	0.4	0.00
P-398	8	382	130	0.3	0.00
P-399	8	249	130	0.1	0.00
P-400	8	253	130	0.1	0.00
P-401	8	171	130	0.0	0.00
P-402	8	381	130	0.0	0.00
P-403	8	381	130	0.0	0.00
P-404	8	542	130	0.1	0.00
P-405	8	377	130	0.7	0.00
P-406	8	328	130	0.1	0.00
P-407	8	649	120	1.3	0.00
P-408	8	541	120	1.4	0.00
P-409	8	420	120	0.2	0.00
P-410	8	928	120	0.0	0.00
P-411	8	462	120	0.1	0.00
P-412	8	770	120	0.1	0.00
P-413	8	470	120	0.7	0.00
P-414	8	461	120	0.6	0.00
P-415	6	578	120	0.2	0.00
P-416	6	381	120	0.4	0.00
P-417	8	463	130	0.4	0.00
P-418	8	392	130	0.3	0.00
P-419	8	1,305	130	1.3	0.00
P-420	8	1,418	130	1.3	0.00
P-421	8	192	130	0.5	0.00
P-422	8	204	130	0.5	0.00
P-423	6	521	120	0.0	0.00
P-424	6	416	120	0.0	0.00
P-425	8	264	130	0.2	0.00
P-426	8	267	130	0.1	0.00
P-427	8	342	130	0.0	0.00
P-428	8	541	130	0.1	0.00
P-429	8	259	130	0.3	0.00
P-430	8	263	130	0.1	0.00
P-431	8	411	130	0.0	0.00
P-432	8	271	130	0.0	0.00
P-433	8	368	130	0.0	0.00
P-434	8	261	130	0.0	0.00
P-435	8	254	130	0.1	0.00
P-436	8	542	130	0.0	0.00
P-437	8	257	130	0.2	0.00
P-438	8	201	130	0.8	0.00

Existing Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Headloss Gradient (ft/1,000 ft)
P-439	8	339	130	0.4	0.00
P-440	8	258	130	0.1	0.00
P-441	8	596	130	0.0	0.00
P-442	8	267	130	0.1	0.00
P-443	8	600	130	0.1	0.00
P-444	8	596	130	0.5	0.00
P-445	8	269	130	0.2	0.00
P-446	6	27	120	0.0	0.00
P-448	8	408	130	0.1	0.00
P-449	8	749	130	0.1	0.00
P-449	6	50	120	0.0	0.00
P-450	8	280	130	0.1	0.00
P-451	8	291	130	0.0	0.00
P-452	8	416	130	0.0	0.00
P-454	8	391	130	0.0	0.00
P-455	8	90	130	0.0	0.00
P-459	8	276	130	0.0	0.00
P-460	8	253	130	0.0	0.00
P-471	8	112	130	0.0	0.00

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-1	1,500	1,824	TRUE	J-5	24.4
J-2	3,000	2,475	FALSE	J-320	20.0
J-3	3,000	2,457	FALSE	J-218	20.0
J-4	1,500	2,428	TRUE	J-11	20.0
J-5	2,500	1,869	FALSE	J-312	21.9
J-6	3,000	2,031	FALSE	J-320	20.3
J-7	1,500	2,488	TRUE	J-11	22.4
J-8	1,500	2,060	TRUE	J-9	20.0
J-9	1,500	1,785	TRUE	J-8	30.9
J-11	1,500	1,848	TRUE	J-4	38.3
J-12	1,500	2,573	TRUE	J-324	21.4
J-13	1,500	2,360	TRUE	J-9	24.1
J-14	3,000	2,677	FALSE	J-10	20.9
J-15	3,000	2,683	FALSE	J-14	20.9
J-16	3,000	2,308	FALSE	J-119	20.0
J-17	2,500	2,647	TRUE	J-217	20.7
J-18	1,500	1,896	TRUE	J-239	20.0
J-19	1,500	1,425	FALSE	J-20	20.0
J-21	1,500	1,538	TRUE	J-20	20.0
J-22	1,500	2,162	TRUE	J-20	20.0
J-23	1,500	2,189	TRUE	J-24	20.0
J-24	1,500	2,152	TRUE	J-23	21.4
J-25	4,000	2,208	FALSE	J-188	23.5
J-26	4,000	2,465	FALSE	J-234	23.6
J-27	1,500	2,257	TRUE	J-29	28.8
J-28	1,500	2,345	TRUE	J-29	23.5
J-29	1,500	2,144	TRUE	J-216	21.2
J-30	1,500	2,551	TRUE	J-28	27.1
J-31	1,500	1,560	TRUE	J-32	43.7
J-32	1,500	2,250	TRUE	J-31	20.0
J-33	1,500	2,772	TRUE	J-32	23.8
J-34	3,000	2,769	FALSE	J-221	22.3
J-35	3,000	2,835	FALSE	J-139	20.0
J-36	3,000	3,181	TRUE	J-140	24.7
J-37	1,500	3,296	TRUE	J-252	20.3
J-38	1,500	1,948	TRUE	J-39	48.4
J-39	1,500	3,160	TRUE	J-38	20.0
J-40	1,500	3,007	TRUE	J-137	27.7
J-41	1,500	2,765	TRUE	J-160	22.5
J-42	1,500	2,853	TRUE	J-206	21.0
J-43	1,500	2,934	TRUE	J-42	21.9
J-44	1,500	3,312	TRUE	J-43	22.3
J-45	1,500	3,225	TRUE	J-44	27.7
J-46	1,500	3,215	TRUE	J-36	27.3
J-47	2,500	3,277	TRUE	J-44	26.6
J-48	1,500	2,541	TRUE	J-51	22.1
J-49	1,500	2,198	TRUE	J-51	20.0
J-50	3,000	2,867	FALSE	J-222	25.4
J-51	1,500	1,802	TRUE	J-49	35.1

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-53	3,000	2,825	FALSE	J-60	34.1
J-54	1,500	3,860	TRUE	J-53	21.5
J-55	1,500	3,752	TRUE	J-54	29.4
J-56	1,500	4,099	TRUE	J-54	23.0
J-57	1,500	3,953	TRUE	J-58	21.6
J-58	1,500	3,688	TRUE	J-59	21.6
J-59	1,500	3,459	TRUE	J-62	22.1
J-60	3,000	2,243	FALSE	J-61	46.2
J-61	3,000	2,899	FALSE	J-65	26.8
J-62	1,500	3,297	TRUE	J-63	20.6
J-63	1,500	3,156	TRUE	J-69	23.0
J-64	2,500	3,099	TRUE	J-61	21.6
J-65	2,500	2,635	TRUE	J-67	24.6
J-66	1,500	2,917	TRUE	J-65	22.4
J-67	2,500	2,524	TRUE	J-223	20.4
J-68	2,500	2,560	TRUE	J-223	22.3
J-69	1,500	3,126	TRUE	J-70	20.2
J-70	1,500	3,002	TRUE	J-69	23.9
J-71	1,500	3,046	TRUE	J-300	21.8
J-72	1,500	3,162	TRUE	J-73	20.0
J-73	1,500	1,963	TRUE	J-72	48.8
J-74	1,500	3,288	TRUE	J-77	20.2
J-75	1,500	2,936	TRUE	J-77	20.0
J-76	1,500	3,463	TRUE	J-74	21.5
J-77	1,500	1,966	TRUE	J-75	45.8
J-78	1,500	3,696	TRUE	J-76	21.6
J-79	1,500	3,959	TRUE	J-78	21.6
J-80	3,000	4,330	TRUE	J-79	22.5
J-81	3,000	2,970	FALSE	J-82	40.4
J-82	3,000	3,616	TRUE	J-81	25.7
J-83	2,500	3,662	TRUE	J-84	23.0
J-84	1,500	3,424	TRUE	J-345	26.8
J-85	1,500	3,637	TRUE	J-345	22.6
J-86	1,500	3,606	TRUE	J-343	22.9
J-87	1,500	2,087	TRUE	J-195	50.3
J-88	1,500	3,427	TRUE	J-323	20.0
J-89	1,500	2,468	TRUE	J-323	20.0
J-90	1,500	2,856	TRUE	J-245	26.6
J-91	1,500	3,307	TRUE	J-323	30.9
J-92	2,500	3,065	TRUE	J-247	20.1
J-93	1,500	3,314	TRUE	J-248	20.1
J-94	1,500	3,921	TRUE	J-93	21.7
J-95	1,500	4,188	TRUE	J-246	24.5
J-96	1,500	4,500	TRUE	J-97	25.8
J-97	1,500	4,256	TRUE	J-321	25.2
J-98	3,000	2,488	FALSE	J-321	20.0
J-99	1,500	2,806	TRUE	J-100	22.2
J-100	1,500	2,309	TRUE	J-99	38.3
J-101	1,500	2,094	TRUE	J-321	20.0

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-102	1,500	2,975	TRUE	J-104	20.4
J-103	1,500	2,860	TRUE	J-104	20.0
J-104	1,500	2,259	TRUE	J-103	36.7
J-105	1,500	2,324	TRUE	J-106	30.7
J-106	1,500	2,672	TRUE	J-105	20.0
J-107	1,500	2,556	TRUE	J-110	20.0
J-108	1,500	2,517	TRUE	J-303	20.9
J-109	1,500	2,095	TRUE	J-107	34.5
J-110	1,500	1,694	TRUE	J-107	45.5
J-111	1,500	1,726	TRUE	J-106	46.6
J-112	1,500	2,653	TRUE	J-115	30.7
J-113	1,500	2,966	TRUE	J-114	20.0
J-114	1,500	2,184	TRUE	J-113	40.5
J-115	1,500	3,054	TRUE	J-112	20.0
J-116	2,500	3,111	TRUE	J-117	23.0
J-117	2,500	3,228	TRUE	J-116	20.0
J-118	2,500	3,406	TRUE	J-117	20.5
J-119	1,500	1,821	TRUE	J-16	36.7
J-120	1,500	2,799	TRUE	J-233	24.4
J-121	2,500	3,518	TRUE	J-118	21.4
J-122	3,000	3,062	TRUE	J-123	23.8
J-123	3,000	3,115	TRUE	J-122	21.9
J-125	3,000	2,308	FALSE	J-124	21.8
J-126	3,000	2,324	FALSE	J-124	20.0
J-128	3,000	2,326	FALSE	J-129	20.0
J-130	1,500	3,062	TRUE	J-131	20.0
J-131	1,500	1,537	TRUE	J-130	54.4
J-132	1,500	3,124	TRUE	J-220	21.6
J-133	3,000	3,209	TRUE	J-132	22.2
J-134	4,000	2,714	FALSE	J-135	29.0
J-135	4,000	2,587	FALSE	J-26	28.1
J-136	4,000	2,157	FALSE	J-234	22.0
J-137	1,500	2,824	TRUE	J-33	27.1
J-139	3,000	2,119	FALSE	J-138	20.0
J-140	3,000	2,949	FALSE	J-35	29.5
J-142	2,500	4,357	TRUE	J-190	28.3
J-143	1,500	4,326	TRUE	J-146	27.0
J-144	1,500	3,340	TRUE	J-190	20.0
J-145	2,500	3,688	TRUE	J-190	27.7
J-146	2,500	4,018	TRUE	J-143	33.6
J-147	1,500	1,974	TRUE	J-148	53.9
J-148	2,500	3,596	TRUE	J-147	20.0
J-149	2,500	3,894	TRUE	J-147	23.1
J-150	3,000	4,104	TRUE	J-149	24.2
J-151	2,500	3,318	TRUE	J-152	34.6
J-152	1,500	3,406	TRUE	J-151	32.7
J-153	1,500	4,383	TRUE	J-235	21.7
J-154	1,500	1,914	TRUE	J-155	45.1
J-155	1,500	2,548	TRUE	J-154	28.0

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-156	1,500	2,805	TRUE	J-302	20.0
J-157	1,500	1,796	TRUE	J-206	35.5
J-158	1,500	1,675	TRUE	J-207	34.7
J-159	1,500	2,042	TRUE	J-208	20.0
J-161	1,500	2,490	TRUE	J-160	20.0
J-162	1,500	2,366	TRUE	J-163	20.0
J-163	1,500	1,759	TRUE	J-162	40.3
J-164	1,500	2,541	TRUE	J-253	32.6
J-165	3,000	2,928	FALSE	J-166	26.0
J-166	3,000	3,026	TRUE	J-165	22.3
J-167	3,000	4,500	TRUE	J-320	30.6
J-168	3,000	4,500	TRUE	J-320	33.1
J-169	3,000	4,500	TRUE	J-320	32.7
J-170	1,500	4,500	TRUE	J-320	40.0
J-171	1,500	4,500	TRUE	J-96	32.2
J-172	1,500	4,500	TRUE	J-226	36.5
J-173	1,500	3,988	TRUE	J-174	20.0
J-176	3,000	2,940	FALSE	J-175	20.0
J-177	3,000	3,040	TRUE	J-178	20.6
J-178	3,000	3,016	TRUE	J-258	20.7
J-179	1,500	1,739	TRUE	J-181	20.3
J-180	1,500	1,723	TRUE	J-181	20.0
J-181	1,500	1,193	FALSE	J-180	43.5
J-182	1,500	959	FALSE	J-325	34.3
J-183	1,500	1,538	TRUE	J-213	27.4
J-184	1,500	1,687	TRUE	J-185	20.0
J-185	1,500	1,627	TRUE	J-184	23.1
J-186	1,500	1,635	TRUE	J-187	23.0
J-187	1,500	1,694	TRUE	J-186	20.0
J-188	4,000	1,777	FALSE	J-186	20.6
J-189	1,500	1,739	TRUE	J-182	20.0
J-190	2,500	2,723	TRUE	J-144	35.8
J-191	2,500	2,599	TRUE	J-192	20.0
J-193	1,500	3,474	TRUE	J-191	35.7
J-194	1,500	3,870	TRUE	J-87	21.6
J-195	2,500	3,449	TRUE	J-87	20.0
J-196	1,500	3,817	TRUE	J-344	23.0
J-197	2,500	3,999	TRUE	J-194	20.3
J-199	2,500	4,259	TRUE	J-142	30.0
J-200	1,500	3,795	TRUE	J-95	38.1
J-201	1,500	4,356	TRUE	J-229	22.7
J-202	3,000	3,240	TRUE	J-141	39.8
J-203	1,500	4,500	TRUE	J-200	28.8
J-204	1,500	2,326	TRUE	J-323	21.2
J-205	1,500	2,225	TRUE	J-323	45.5
J-206	1,500	2,207	TRUE	J-157	20.0
J-207	1,500	2,028	TRUE	J-158	20.0
J-208	1,500	1,484	FALSE	J-159	42.2
J-209	3,000	3,326	TRUE	J-52	20.0

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-210	3,000	3,292	TRUE	J-141	20.0
J-211	1,500	3,234	TRUE	J-90	30.7
J-212	1,500	2,762	TRUE	J-33	27.4
J-213	1,500	1,687	TRUE	J-183	20.0
J-215	1,500	1,801	TRUE	J-325	22.3
J-216	1,500	1,929	TRUE	J-215	22.0
J-217	1,500	2,108	TRUE	J-239	21.6
J-218	1,500	1,616	TRUE	J-320	44.9
J-221	1,500	2,580	TRUE	J-34	28.8
J-222	1,500	2,408	TRUE	J-48	33.8
J-223	2,500	2,333	FALSE	J-67	27.4
J-224	1,500	2,812	TRUE	J-154	20.0
J-225	1,500	2,371	TRUE	J-255	20.8
J-226	1,500	2,158	TRUE	J-100	56.5
J-227	1,500	2,696	TRUE	J-228	26.0
J-228	4,000	2,739	FALSE	J-227	25.2
J-229	3,000	4,274	TRUE	J-201	24.8
J-230	3,000	1,410	FALSE	J-139	46.9
J-231	1,500	4,499	TRUE	J-198	20.0
J-232	1,500	4,500	TRUE	J-320	40.4
J-233	1,500	2,882	TRUE	J-120	21.2
J-234	4,000	2,171	FALSE	J-136	21.2
J-235	1,500	4,380	TRUE	J-57	21.8
J-236	3,000	2,665	FALSE	J-10	20.0
J-237	1,500	4,500	TRUE	J-320	42.3
J-238	1,500	3,221	TRUE	J-45	29.3
J-245	1,500	2,372	TRUE	J-225	23.2
J-246	1,500	3,147	TRUE	J-211	33.3
J-247	1,500	2,510	TRUE	J-92	35.4
J-248	1,500	2,652	TRUE	J-93	36.8
J-249	2,500	4,500	TRUE	J-201	25.3
J-250	1,500	1,440	FALSE	J-20	20.5
J-251	1,500	1,488	FALSE	J-250	20.4
J-252	1,500	3,122	TRUE	J-37	25.2
J-253	3,000	2,817	FALSE	J-164	24.1
J-254	1,500	2,271	TRUE	J-255	20.0
J-255	1,500	2,036	TRUE	J-254	28.2
J-256	1,500	2,237	TRUE	J-257	20.0
J-257	1,500	2,009	TRUE	J-256	28.1
J-258	1,500	2,654	TRUE	J-23	24.4
J-259	1,500	2,920	TRUE	J-68	21.1
J-260	1,500	2,263	TRUE	J-262	21.9
J-261	1,500	2,244	TRUE	J-262	20.0
J-262	1,500	2,062	TRUE	J-261	26.5
J-263	1,500	2,284	TRUE	J-291	21.0
J-264	1,500	2,244	TRUE	J-265	22.8
J-265	1,500	2,292	TRUE	J-264	20.9
J-266	1,500	2,309	TRUE	J-279	20.2
J-267	1,500	2,303	TRUE	J-346	20.8

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-268	1,500	2,300	TRUE	J-328	20.6
J-269	1,500	2,272	TRUE	J-292	21.0
J-270	1,500	2,278	TRUE	J-279	20.5
J-271	1,500	2,237	TRUE	J-281	21.0
J-272	1,500	2,241	TRUE	J-279	20.0
J-273	1,500	2,206	TRUE	J-274	21.0
J-274	1,500	2,189	TRUE	J-275	20.8
J-275	1,500	2,143	TRUE	J-278	20.3
J-276	1,500	2,155	TRUE	J-279	20.1
J-277	1,500	2,059	TRUE	J-279	20.0
J-278	1,500	2,065	TRUE	J-279	22.4
J-279	1,500	1,749	TRUE	J-277	31.8
J-280	1,500	2,201	TRUE	J-292	20.9
J-281	1,500	2,219	TRUE	J-274	21.2
J-282	1,500	2,219	TRUE	J-274	21.2
J-283	1,500	2,227	TRUE	J-282	21.4
J-284	1,500	2,189	TRUE	J-323	20.0
J-285	1,500	2,314	TRUE	J-323	20.2
J-286	1,500	2,315	TRUE	J-323	20.3
J-287	1,500	2,237	TRUE	J-288	21.2
J-288	1,500	2,240	TRUE	J-287	21.0
J-289	1,500	2,359	TRUE	J-288	20.3
J-290	1,500	2,302	TRUE	J-291	20.8
J-291	1,500	2,254	TRUE	J-263	22.3
J-292	1,500	2,198	TRUE	J-280	21.0
J-293	1,500	2,391	TRUE	J-323	20.7
J-294	1,500	2,872	TRUE	J-301	20.0
J-295	1,500	2,973	TRUE	J-301	21.1
J-296	1,500	2,960	TRUE	J-297	21.6
J-297	1,500	2,858	TRUE	J-298	21.5
J-298	2,500	2,647	TRUE	J-299	27.6
J-299	2,500	2,874	TRUE	J-298	20.8
J-300	1,500	3,051	TRUE	J-299	20.4
J-301	1,500	2,712	TRUE	J-294	24.8
J-302	1,500	2,561	TRUE	J-156	27.5
J-303	1,500	2,491	TRUE	J-310	20.1
J-304	1,500	2,454	TRUE	J-307	20.1
J-305	1,500	2,439	TRUE	J-311	20.2
J-306	1,500	2,485	TRUE	J-324	23.0
J-308	1,500	1,993	TRUE	J-304	35.0
J-309	1,500	2,197	TRUE	J-303	29.7
J-310	1,500	1,624	TRUE	J-303	46.1
J-311	1,500	2,099	TRUE	J-305	31.3
J-312	1,500	1,892	TRUE	J-313	20.5
J-313	1,500	1,857	TRUE	J-319	21.5
J-314	1,500	1,894	TRUE	J-313	20.5
J-315	1,500	1,907	TRUE	J-318	20.5
J-316	1,500	1,924	TRUE	J-320	20.0
J-317	1,500	1,861	TRUE	J-320	20.0

Existing Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-318	1,500	1,888	TRUE	J-320	20.5
J-319	1,500	1,882	TRUE	J-313	20.4
J-320	1,500	1,611	TRUE	J-317	30.7
J-321	1,500	1,894	TRUE	J-101	28.6
J-322	1,500	1,420	FALSE	J-323	20.0
J-323	1,500	1,089	FALSE	J-322	37.8
J-324	1,500	2,520	TRUE	J-306	21.5
J-325	1,500	1,156	FALSE	J-182	20.0
J-326	1,500	2,240	TRUE	J-283	21.1
J-327	1,500	2,251	TRUE	J-336	21.3
J-328	1,500	2,258	TRUE	J-329	21.5
J-329	1,500	2,269	TRUE	J-330	20.4
J-330	1,500	2,203	TRUE	J-331	20.6
J-331	1,500	1,501	TRUE	J-352	41.6
J-332	1,500	2,179	TRUE	J-333	20.7
J-333	1,500	2,084	TRUE	J-351	20.7
J-334	1,500	2,177	TRUE	J-356	21.3
J-335	1,500	2,251	TRUE	J-338	20.5
J-336	1,500	2,250	TRUE	J-327	21.4
J-337	1,500	2,261	TRUE	J-323	20.1
J-338	1,500	1,501	TRUE	J-283	44.4
J-341	1,500	2,902	TRUE	J-233	27.3
J-342	1,500	2,142	TRUE	J-20	24.5
J-343	1,500	3,175	TRUE	J-86	32.5
J-344	1,500	3,399	TRUE	J-83	30.8
J-345	1,500	2,485	TRUE	J-84	46.1
J-346	1,500	2,210	TRUE	J-268	24.0
J-347	1,500	1,501	TRUE	J-348	43.6
J-348	1,500	1,501	TRUE	J-349	42.7
J-349	1,500	1,501	TRUE	J-350	42.5
J-350	1,500	1,501	TRUE	J-351	42.2
J-351	1,500	1,501	TRUE	J-333	41.4
J-352	1,500	1,501	TRUE	J-331	41.6
J-356	1,500	1,501	TRUE	J-332	43.6

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-1	77.1	56.90	70.70	240.60
J-2	76.8	5.80	69.50	237.40
J-3	76.5	12.82	69.60	237.40
J-4	76.8	2.99	69.10	236.60
J-5	77.7	21.34	70.80	241.30
J-6	77.8	25.99	70.10	239.80
J-7	77.0	27.74	69.10	236.70
J-8	76.5	16.84	69.30	236.50
J-9	76.5	9.52	69.20	236.50
J-10	76.6	3.51	69.30	236.80
J-11	76.8	18.95	69.10	236.50
J-12	76.6	0.96	68.70	235.20
J-13	76.3	13.84	69.30	236.50
J-14	76.0	0.00	69.60	236.90
J-15	76.0	3.56	69.70	237.00
J-16	75.9	18.13	69.60	236.80
J-17	75.9	15.19	69.80	237.30
J-18	76.0	20.53	69.80	237.40
J-19	75.9	8.31	71.00	239.90
J-20	75.9	2.38	70.90	239.90
J-21	75.8	9.91	71.00	239.90
J-22	75.7	6.88	71.00	239.90
J-23	75.7	6.79	70.90	239.60
J-24	75.7	22.48	70.90	239.60
J-25	75.8	19.86	72.70	243.80
J-26	75.5	18.15	71.50	240.80
J-27	75.6	14.76	71.20	240.20
J-28	75.6	11.05	70.80	239.20
J-29	75.6	11.69	71.20	240.20
J-30	75.5	14.35	69.60	236.40
J-31	75.4	12.95	70.40	238.10
J-32	75.5	7.32	70.40	238.10
J-33	75.3	3.65	70.10	237.40
J-34	75.2	2.29	69.70	236.30
J-35	75.1	7.66	69.30	235.20
J-36	75.1	5.25	68.70	233.90
J-37	75.2	3.76	68.70	233.90
J-38	75.3	9.03	68.70	234.20
J-39	75.3	10.49	68.80	234.20
J-40	75.3	14.03	69.30	235.50
J-41	75.4	6.63	68.60	233.90
J-42	75.3	6.75	68.20	233.00
J-43	75.3	6.92	68.20	233.00
J-44	75.2	11.34	68.30	233.00
J-45	75.2	5.28	68.40	233.40
J-46	75.1	5.21	68.50	233.40
J-47	75.1	3.34	68.30	233.00
J-48	75.1	6.92	68.10	232.60

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-49	75.0	4.75	68.10	232.50
J-50	75.1	13.54	68.10	232.60
J-51	75.0	50.65	68.10	232.40
J-52	75.0	8.53	67.70	231.40
J-53	75.0	7.38	67.50	231.00
J-54	75.0	0.95	67.60	231.20
J-55	75.0	3.59	67.70	231.40
J-56	74.7	16.22	67.50	230.80
J-57	74.5	10.06	67.00	229.40
J-58	74.5	17.01	67.00	229.40
J-59	74.5	19.23	67.00	229.30
J-60	74.9	23.91	67.20	230.20
J-61	74.8	36.96	67.00	229.70
J-62	74.3	9.15	67.10	229.30
J-63	74.2	13.48	67.10	229.30
J-64	74.5	22.94	67.00	229.40
J-65	74.7	16.53	67.00	229.50
J-66	74.4	9.65	67.10	229.40
J-67	74.4	2.47	67.00	229.30
J-68	74.0	6.31	67.20	229.30
J-69	74.0	5.28	67.20	229.20
J-70	74.0	10.66	67.20	229.20
J-71	74.0	6.48	67.20	229.20
J-72	74.0	8.18	67.20	229.30
J-73	74.0	7.93	67.20	229.30
J-74	74.1	8.35	67.10	229.30
J-75	74.0	6.76	67.20	229.20
J-76	74.1	10.89	67.10	229.30
J-77	74.0	10.59	67.20	229.20
J-78	74.1	14.91	67.20	229.40
J-79	74.2	13.43	67.20	229.50
J-80	74.2	9.07	67.40	230.10
J-81	74.0	18.45	67.90	230.90
J-82	74.0	12.64	68.10	231.40
J-83	74.0	21.75	68.30	231.80
J-84	74.5	51.16	68.10	231.90
J-85	74.6	11.43	68.20	232.20
J-86	75.0	10.99	68.10	232.30
J-87	75.0	16.82	68.10	232.40
J-88	75.0	16.03	68.20	232.70
J-89	75.0	8.61	68.30	232.80
J-90	75.3	13.34	69.10	235.10
J-91	75.0	16.47	68.50	233.40
J-92	75.0	17.98	68.60	233.50
J-93	74.9	12.63	68.60	233.60
J-94	75.0	13.73	68.60	233.70
J-95	75.1	10.88	69.00	234.70
J-96	75.2	5.23	69.50	235.70

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-97	75.2	23.68	69.40	235.70
J-98	75.3	17.29	69.30	235.40
J-99	75.3	12.44	69.20	235.20
J-100	75.2	13.87	69.20	235.30
J-101	75.4	18.52	69.20	235.40
J-102	75.7	11.97	68.80	234.90
J-103	75.8	14.20	68.70	234.70
J-104	75.8	20.37	68.70	234.70
J-105	76.0	11.44	68.60	234.60
J-106	76.0	5.31	68.60	234.60
J-107	76.2	5.18	68.50	234.50
J-108	76.3	4.91	68.50	234.50
J-109	76.0	56.56	68.60	234.50
J-110	76.1	8.39	68.50	234.50
J-111	75.9	9.08	68.70	234.60
J-112	75.9	3.28	69.00	235.40
J-113	75.7	5.17	69.00	235.20
J-114	75.6	16.08	69.00	235.20
J-115	75.8	3.38	69.10	235.40
J-116	75.6	5.74	69.20	235.60
J-117	75.6	5.48	69.20	235.60
J-118	75.6	8.02	69.30	235.70
J-119	76.1	10.55	69.60	236.80
J-120	76.7	6.87	68.90	235.90
J-121	75.6	9.03	69.40	235.90
J-122	75.7	5.22	69.70	236.90
J-123	75.7	9.02	69.70	236.80
J-124	75.6	8.67	69.70	236.80
J-125	75.5	0.92	69.80	236.80
J-126	75.5	1.58	69.70	236.80
J-127	75.4	2.71	70.00	237.20
J-128	75.4	1.13	69.80	236.70
J-129	75.4	5.86	69.80	236.70
J-130	75.3	8.04	70.10	237.30
J-131	75.4	27.06	70.00	237.20
J-132	75.3	6.51	70.10	237.30
J-133	75.2	5.78	70.10	237.30
J-134	75.3	11.64	70.60	238.50
J-135	75.4	21.98	71.00	239.60
J-136	75.6	11.14	72.10	242.30
J-137	75.3	7.58	69.70	236.50
J-138	75.0	2.06	69.40	235.40
J-139	75.1	1.70	69.40	235.40
J-140	75.1	13.11	68.90	234.30
J-141	75.0	3.76	68.70	233.80
J-142	74.8	10.34	68.80	233.90
J-143	74.5	14.03	68.90	233.70
J-144	74.8	7.25	68.50	233.10

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-145	74.7	4.95	68.40	232.70
J-146	74.3	16.82	68.70	233.00
J-147	74.5	15.65	67.90	231.40
J-148	74.5	10.11	67.90	231.40
J-149	74.2	15.13	67.90	231.10
J-150	74.1	13.13	67.70	230.70
J-151	74.0	17.86	68.10	231.40
J-152	74.0	11.90	68.10	231.30
J-153	74.5	8.99	67.10	229.70
J-154	74.0	22.53	67.10	229.20
J-155	74.0	40.97	67.10	229.20
J-156	74.0	4.37	67.10	229.20
J-157	75.3	6.97	68.10	232.80
J-158	75.1	5.90	68.10	232.60
J-159	75.0	11.43	68.10	232.50
J-160	75.5	4.57	68.60	234.10
J-161	75.5	5.69	68.80	234.40
J-162	75.5	4.31	69.10	235.30
J-163	75.4	8.27	69.10	235.30
J-164	75.2	10.33	70.10	237.20
J-165	75.2	3.00	69.90	236.70
J-166	75.2	3.55	69.90	236.70
J-167	75.2	5.98	69.70	236.40
J-168	75.1	5.36	69.70	236.20
J-169	75.1	1.60	69.80	236.40
J-170	74.9	1.71	69.80	236.30
J-171	75.1	6.60	69.60	236.00
J-172	75.0	10.83	69.80	236.30
J-173	75.3	9.13	69.60	236.20
J-174	75.4	5.88	69.60	236.20
J-175	75.4	24.12	69.90	237.10
J-176	75.4	9.80	70.00	237.30
J-177	75.6	5.24	70.00	237.30
J-178	75.6	13.38	70.00	237.30
J-179	76.0	12.91	75.00	249.30
J-180	76.0	3.61	75.00	249.30
J-181	76.0	0.00	75.00	249.40
J-182	76.0	0.00	72.40	243.20
J-183	75.8	7.10	74.60	248.20
J-184	75.8	1.00	74.70	248.50
J-185	75.8	0.98	74.70	248.50
J-186	75.8	1.05	74.50	247.90
J-187	75.7	1.42	74.50	247.90
J-188	75.9	16.53	74.10	247.10
J-189	75.9	22.26	72.40	243.20
J-190	74.8	9.94	68.50	233.10
J-191	74.8	11.25	68.30	232.60
J-192	74.8	13.69	68.30	232.60

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-193	75.0	5.82	67.70	231.40
J-194	74.7	5.58	68.20	232.30
J-195	74.9	11.83	68.20	232.40
J-196	74.3	10.57	68.30	232.20
J-197	74.6	7.60	68.20	232.30
J-198	74.8	6.04	68.90	234.10
J-199	75.0	6.28	69.10	234.70
J-200	74.9	7.04	69.20	234.80
J-201	75.1	2.33	69.40	235.40
J-202	75.0	7.29	69.10	234.70
J-203	74.8	5.12	69.30	234.90
J-204	75.0	6.45	68.30	232.80
J-205	75.0	17.49	68.20	232.70
J-206	75.3	5.41	68.10	232.80
J-207	75.1	5.75	68.10	232.60
J-208	75.0	66.06	68.10	232.30
J-209	75.1	8.34	68.00	232.10
J-210	75.0	12.02	68.70	233.80
J-211	75.2	5.56	68.90	234.50
J-212	75.3	7.79	70.20	237.50
J-213	75.8	2.59	74.60	248.20
J-215	75.9	28.44	71.90	242.10
J-216	75.7	23.49	71.50	241.00
J-217	76.0	7.31	69.80	237.30
J-218	76.9	8.74	69.40	237.40
J-219	75.5	4.86	69.90	237.10
J-220	75.3	2.67	70.10	237.20
J-221	75.2	9.50	69.70	236.30
J-222	75.1	17.24	68.10	232.60
J-223	74.3	3.65	67.10	229.40
J-224	74.0	3.31	67.10	229.20
J-225	75.2	25.37	69.10	235.00
J-226	75.2	14.08	69.60	236.00
J-227	75.6	12.53	69.00	235.00
J-228	75.6	23.58	68.90	234.90
J-229	75.2	3.80	69.40	235.40
J-230	75.1	7.39	69.60	235.90
J-231	74.7	9.02	69.00	234.10
J-232	75.0	3.55	69.80	236.40
J-233	76.6	4.19	68.90	235.70
J-234	75.6	9.38	72.00	242.10
J-235	74.5	9.07	67.00	229.30
J-236	76.0	5.69	69.60	236.80
J-237	75.1	0.00	70.00	236.80
J-238	75.1	12.78	68.50	233.40
J-239	76.0	40.67	69.70	237.00
J-240	75.9	8.39	69.70	237.00
J-241	75.8	12.93	69.70	237.00

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-242	75.9	17.97	69.70	237.00
J-243	75.8	15.06	69.70	237.00
J-244	75.8	7.59	69.70	237.00
J-245	75.3	19.38	69.10	235.00
J-246	75.2	18.24	69.00	234.60
J-247	74.8	9.14	68.70	233.50
J-248	74.7	14.37	68.70	233.60
J-249	75.0	5.96	69.40	235.40
J-250	75.8	6.32	71.00	239.90
J-251	75.7	10.28	71.00	239.90
J-252	75.3	7.94	68.60	233.90
J-253	75.2	6.42	70.10	237.10
J-254	75.2	4.41	68.90	234.50
J-255	75.2	7.41	68.90	234.50
J-256	75.1	5.12	68.70	234.00
J-257	75.1	11.79	68.70	234.00
J-258	75.5	32.32	70.20	237.70
J-259	74.3	11.58	67.10	229.30
J-260	75.1	0.00	69.20	235.00
J-261	75.0	9.48	68.90	234.20
J-262	75.1	7.07	68.80	234.20
J-263	75.0	8.97	68.50	233.40
J-264	75.0	8.21	68.50	233.20
J-265	74.8	9.06	68.50	233.10
J-266	74.7	7.25	68.40	232.90
J-267	74.8	11.77	68.40	232.90
J-268	74.8	12.25	68.40	232.80
J-269	74.5	15.99	68.50	232.80
J-270	74.3	34.71	68.60	232.80
J-271	74.3	10.22	68.50	232.80
J-272	74.7	9.10	68.40	232.80
J-273	74.9	13.57	68.30	232.80
J-274	75.0	9.91	68.20	232.80
J-275	75.1	9.09	68.20	232.80
J-276	74.9	9.88	68.30	232.80
J-277	75.0	11.43	68.20	232.80
J-278	75.2	10.01	68.20	232.80
J-279	75.3	10.20	68.10	232.80
J-280	74.6	10.80	68.50	232.80
J-281	74.4	13.68	68.50	232.80
J-282	74.5	11.28	68.50	232.80
J-283	74.2	43.43	68.60	232.80
J-326	74.2	0.00	68.60	232.80
J-327	74.3	0.00	68.60	232.80
J-328	74.9	0.00	68.30	232.80
J-329	74.8	0.00	68.30	232.80
J-330	74.7	1.55	68.40	232.80
J-331	74.5	4.32	68.50	232.80

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-332	74.5	1.39	68.50	232.80
J-333	74.3	4.18	68.60	232.80
J-334	73.9	0.54	68.70	232.80
J-335	74.0	0.00	68.70	232.80
J-336	74.3	0.00	68.60	232.80
J-337	75.0	0.00	68.30	232.80
J-284	75.0	35.93	68.30	232.80
J-285	75.0	6.76	68.30	232.80
J-286	75.0	9.59	68.30	232.80
J-287	75.0	5.77	68.30	232.90
J-288	75.0	6.81	68.30	232.90
J-289	75.0	5.49	68.40	233.00
J-290	75.0	8.19	68.40	233.10
J-291	75.1	5.44	68.40	233.30
J-292	74.5	7.31	68.50	232.80
J-338	73.8	0.00	68.80	232.80
J-339	75.1	56.76	69.50	235.60
J-293	75.0	9.61	68.40	233.00
J-294	74.0	8.17	67.10	229.20
J-295	74.0	11.69	67.20	229.20
J-296	73.7	16.98	67.30	229.20
J-297	73.5	24.65	67.40	229.20
J-298	73.6	12.90	67.30	229.20
J-299	73.8	7.81	67.30	229.20
J-300	73.8	5.63	67.20	229.20
J-301	74.0	39.48	67.10	229.20
J-302	74.0	10.14	67.10	229.20
J-303	76.4	5.01	68.40	234.50
J-304	76.7	9.36	68.30	234.50
J-305	76.9	28.89	68.20	234.50
J-306	76.6	17.77	68.50	234.90
J-307	76.4	14.75	68.40	234.40
J-308	76.4	9.65	68.40	234.50
J-309	76.2	13.40	68.50	234.50
J-310	76.3	12.10	68.40	234.50
J-311	76.5	101.71	68.30	234.40
J-312	78.0	1.13	70.70	241.60
J-313	78.5	3.25	70.90	242.50
J-340	79.1	28.26	71.30	243.90
J-314	78.1	17.62	70.70	241.50
J-315	78.1	26.66	70.60	241.30
J-316	78.2	11.69	70.40	240.90
J-317	78.9	11.87	70.20	241.10
J-318	78.7	14.48	70.40	241.30
J-319	78.5	14.83	70.60	241.80
J-320	79.5	45.25	69.90	241.10
J-321	75.5	28.70	69.20	235.40
J-341	76.2	11.82	69.00	235.70

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-342	75.7	33.04	71.50	241.00
J-343	75.0	13.17	68.00	232.10
J-344	74.2	10.09	68.30	232.00
J-345	74.6	15.33	68.10	232.00
J-346	74.8	11.06	68.40	232.80
J-347	74.6	9.49	68.40	232.80
J-348	73.9	6.44	68.80	232.80
J-349	73.9	5.88	68.70	232.80
J-350	73.8	5.67	68.80	232.80
J-351	74.2	4.59	68.60	232.80
J-352	74.4	5.28	68.50	232.80
J-322	73.7	4.00	68.70	232.60
J-323	73.0	213.29	69.00	232.50
J-353	73.5	6.25	68.90	232.80
J-354	73.6	3.55	68.90	232.80
J-355	73.8	6.63	68.80	232.80
J-356	74.2	1.04	68.60	232.80
J-357	74.0	5.43	68.70	232.80
J-358	73.4	7.69	69.00	232.80
J-359	73.5	5.94	68.90	232.80
J-360	73.8	4.79	68.80	232.80
J-361	75.1	119.63	70.30	237.60
J-368	79.0	225.73	72.10	245.80
J-369	75.2	55.17	70.20	237.50
J-370	75.5	122.29	69.00	234.90
J-371	75.4	24.38	69.00	235.00
J-372	75.5	123.91	68.90	234.70
J-373	75.7	24.92	68.80	234.70
J-374	75.8	33.92	68.70	234.70
J-375	75.3	23.65	69.10	235.00
J-377	78.6	742.82	70.70	242.10
J-378	74.4	145.02	71.30	239.10
J-379	74.0	302.81	71.30	238.70
J-380	73.2	263.86	71.60	238.60
J-381	71.8	519.40	72.20	238.70
J-382	70.0	537.61	72.10	236.70
J-383	69.3	269.08	72.30	236.50
J-384	69.0	203.53	72.50	236.50
J-385	68.6	269.53	72.70	236.60
J-386	68.5	86.37	71.60	233.90
J-387	68.8	81.78	70.70	232.20
J-388	69.1	145.53	69.90	230.80
J-389	70.7	122.00	69.30	230.80
J-390	71.6	102.91	69.10	231.50
J-391	72.5	47.03	68.90	231.70
J-392	73.5	18.02	68.30	231.40
J-393	75.0	82.63	66.90	229.60
J-394	75.0	132.13	66.70	229.30

Buildout Water System - City of Live Oak
Junction Report - MDD

Label	Elevation (ft)	Demand (gpm)	Pressure (psi)	Hydraulic Grade (ft)
J-395	75.0	137.43	66.70	229.20
J-396	75.0	41.22	66.70	229.20
J-397	74.8	85.96	72.00	241.30
J-398	75.0	161.24	71.80	241.00
J-399	75.6	371.88	71.50	240.80
J-400	77.0	395.73	70.90	240.80
J-401	78.1	541.54	70.50	241.00
J-402	79.7	838.41	72.60	247.40
J-403	80.3	491.76	71.90	246.50
J-404	80.0	63.37	72.00	246.50
J-405	80.0	279.92	72.00	246.50
J-406	80.6	267.09	72.10	247.30
J-407	80.3	221.69	72.20	247.20
J-408	80.0	117.34	72.30	247.20
J-409	79.9	83.63	70.60	243.10
J-410	79.5	121.38	70.80	243.10
J-411	79.0	109.02	71.00	243.10
J-412	78.6	99.02	71.20	243.20
J-413	79.0	207.91	71.60	244.40
J-414	78.2	234.72	73.90	248.90
J-415	77.2	138.83	75.00	250.50
J-416	76.4	160.60	75.00	249.70
J-417	76.0	143.59	75.00	249.40
J-418	73.7	336.59	69.10	233.40
J-419	73.2	385.35	67.60	229.60
J-420	72.2	192.27	68.60	230.60
J-421	70.9	242.28	68.80	230.00
J-422	70.3	138.91	69.10	230.00
J-423	70.3	155.42	70.00	232.20
J-424	69.8	188.00	71.00	233.90
J-426	77.9	431.69	71.20	242.50
J-427	80.0	56.60	71.60	245.60
J-428	79.4	168.81	71.30	244.30
J-324	76.6	1.00	68.50	235.10
J-429	71.2	593.67	68.60	229.70
J-430	71.5	280.90	68.80	230.60
J-431	73.8	276.53	67.60	230.10
J-441	75.0	130.48	66.70	229.20
J-442	75.0	76.18	66.70	229.20
J-443	75.5	6.21	75.20	249.40
J-325	76.0	0.00	72.40	243.20
J-444	75.6	67.32	69.10	235.30
J-445	76.4	151.68	69.30	236.60
J-446	78.2	217.30	69.60	239.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-1	8	184	120	0.5	0.00
P-2	8	323	120	0.2	0.00
P-3	8	265	120	0.4	0.00
P-4	8	339	120	1.1	0.00
P-5	8	245	120	0.7	0.00
P-6	8	460	120	0.3	0.00
P-7	8	325	120	0.4	0.00
P-8	8	155	120	0.3	0.00
P-9	6	285	120	0.7	0.00
P-10	6	235	120	0.2	0.00
P-11	8	258	120	1.5	0.00
P-12	8	280	120	2.5	0.00
P-13	8	474	120	1.0	0.00
P-14	8	368	120	1.3	0.00
P-15	8	307	120	0.6	0.00
P-16	2	374	120	0.5	0.00
P-17	6	135	120	2.0	0.00
P-18	8	491	120	0.3	0.00
P-19	6	313	120	0.2	0.00
P-20	6	299	120	0.0	0.00
P-21	6	402	120	1.1	0.00
P-22	6	99	120	0.1	0.00
P-22P	6	742	120	0.3	0.00
P-23	6	140	120	0.1	0.00
P-23P	6	203	120	0.2	0.00
P-24	8	613	120	0.2	0.00
P-25	8	493	120	0.0	0.00
P-25P	6	150	120	0.2	0.00
P-26	6	564	120	1.6	0.00
P-27	6	400	120	1.9	0.00
P-27P	6	145	120	0.1	0.00
P-28	6	398	120	1.6	0.00
P-28P	6	263	120	0.5	0.00
P-29	6	401	120	1.6	0.00
P-30	6	190	120	0.1	0.00
P-31	6	229	120	0.2	0.00
P-32	8	447	120	0.3	0.00
P-33	6	200	120	0.3	0.00
P-34	6	89	120	0.1	0.00
P-35	8	371	120	0.3	0.00
P-36	8	242	120	0.1	0.00
P-37	6	220	120	0.1	0.00
P-38	6	496	120	0.5	0.00
P-39	8	282	120	0.2	0.00
P-40	8	259	120	0.7	0.00
P-41	8	100	120	0.3	0.00
P-42	6	196	120	0.1	0.00
P-43	8	642	120	0.1	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-44	6	258	120	0.1	0.00
P-45	8	171	120	1.6	0.00
P-46	8	171	120	1.6	0.00
P-47	6	220	120	0.1	0.00
P-48	6	747	120	1.2	0.00
P-49	6	500	120	0.7	0.00
P-50	4	163	120	0.1	0.00
P-50P	6	322	130	1.2	0.00
P-51	8	110	120	0.0	0.00
P-52	6	369	120	0.8	0.00
P-53	8	269	120	0.8	0.00
P-53P	6	651	130	0.1	0.00
P-54	8	269	120	0.7	0.00
P-55	8	131	120	0.2	0.00
P-55P	6	652	130	0.0	0.00
P-56	6	142	120	3.1	0.01
P-57	8	681	120	1.6	0.00
P-58	6	400	120	0.5	0.00
P-59	6	99	120	0.4	0.00
P-60	4	153	120	0.2	0.00
P-61	6	356	120	1.1	0.00
P-62	8	360	120	0.6	0.00
P-63	8	346	120	0.4	0.00
P-64	6	255	120	0.2	0.00
P-65	6	320	120	1.6	0.00
P-66	6	285	120	1.0	0.00
P-67	8	111	120	0.0	0.00
P-68	6	129	120	0.9	0.00
P-69	6	292	120	0.2	0.00
P-70	6	636	120	0.5	0.00
P-71	6	403	120	0.3	0.00
P-72	6	377	120	0.4	0.00
P-73	6	197	120	0.1	0.00
P-74	6	207	120	0.1	0.00
P-75	8	496	120	0.2	0.00
P-76	6	669	120	3.4	0.01
P-77	8	484	120	1.6	0.00
P-78	8	135	120	0.0	0.00
P-79	6	136	120	0.6	0.00
P-80	6	186	120	0.8	0.00
P-81	6	289	120	1.9	0.00
P-82	6	236	120	2.1	0.00
P-83	6	274	120	2.2	0.00
P-84	6	273	120	3.6	0.01
P-85	6	564	120	1.4	0.00
P-86	6	297	120	1.5	0.00
P-87	10	365	120	0.8	0.00
P-88	8	241	120	1.2	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-89	8	413	120	1.0	0.00
P-90	8	112	120	1.3	0.00
P-91	8	396	120	0.4	0.00
P-92	8	283	120	0.6	0.00
P-93a	10	506	130	0.7	0.00
P-94a	10	507	130	1.6	0.00
P-95a	10	163	130	1.7	0.00
P-96a	10	184	130	2.4	0.00
P-97a	10	319	130	2.7	0.00
P-98	6	324	120	2.0	0.00
P-99	8	191	120	0.6	0.00
P-100	8	169	120	0.3	0.00
P-101	8	344	120	0.1	0.00
P-102	8	398	120	0.3	0.00
P-103	6	190	120	0.5	0.00
P-104	8	437	120	1.5	0.00
P-105	6	326	120	1.2	0.00
P-106	8	184	120	1.4	0.00
P-107	6	319	120	2.2	0.00
P-108	6	322	120	1.9	0.00
P-109	6	172	120	2.5	0.01
P-110	6	174	120	0.9	0.00
P-111	6	312	120	1.9	0.00
P-112	8	450	120	0.2	0.00
P-113	6	151	120	0.1	0.00
P-114	8	177	120	0.0	0.00
P-115a	10	346	130	2.5	0.00
P-116	2	260	120	0.9	0.00
P-117a	10	159	130	2.5	0.00
P-118a	10	423	130	1.7	0.00
P-119a	10	609	130	1.8	0.00
P-120a	10	352	130	0.4	0.00
P-121	6	181	120	0.3	0.00
P-122	6	218	120	0.7	0.00
P-123	6	525	120	0.6	0.00
P-124a	10	614	130	0.3	0.00
P-125	6	294	120	0.1	0.00
P-126	6	275	120	0.1	0.00
P-127	6	485	120	1.9	0.00
P-128	4	303	120	0.6	0.00
P-129	6	128	120	0.2	0.00
P-130	8	595	120	0.1	0.00
P-131	8	124	120	0.2	0.00
P-132	8	254	120	0.3	0.00
P-133	8	260	120	0.2	0.00
P-134	8	275	120	0.5	0.00
P-135	8	233	120	0.9	0.00
P-136	8	271	120	0.6	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-137	8	274	120	1.7	0.00
P-138	8	239	120	2.1	0.00
P-139	8	249	120	1.6	0.00
P-140	8	258	120	1.3	0.00
P-141	6	228	120	2.6	0.01
P-142	6	149	120	1.7	0.00
P-143	8	367	120	1.8	0.00
P-144	8	367	120	0.8	0.00
P-145	8	728	120	0.7	0.00
P-146	8	131	120	1.4	0.00
P-147	8	448	120	0.0	0.00
P-148	6	252	120	0.4	0.00
P-149	8	129	120	0.0	0.00
P-150	8	449	120	1.5	0.00
P-151	8	367	120	1.2	0.00
P-152	8	353	120	1.9	0.00
P-153	8	386	120	2.5	0.00
P-154	6	693	120	1.0	0.00
P-155	8	441	120	0.7	0.00
P-156a	12	414	130	5.3	0.01
P-157a	12	278	130	4.3	0.01
P-158a	12	259	130	3.8	0.00
P-159a	12	338	130	3.3	0.00
P-160a	12	491	130	2.8	0.00
P-161a	12	353	130	2.3	0.00
P-162	12	169	120	2.0	0.00
P-163	12	599	120	1.1	0.00
P-164	6	692	120	0.7	0.00
P-165	6	270	120	0.5	0.00
P-166	6	241	120	0.6	0.00
P-167	6	486	120	1.5	0.00
P-168	8	250	120	0.7	0.00
P-169	6	513	120	1.6	0.00
P-170	6	361	120	1.8	0.00
P-171	6	379	120	1.8	0.00
P-172	6	701	120	0.8	0.00
P-173	8	552	120	1.4	0.00
P-174	8	273	120	0.9	0.00
P-175	6	256	120	0.1	0.00
P-176	8	400	120	0.4	0.00
P-177	6	274	120	0.7	0.00
P-178	6	292	120	0.8	0.00
P-179	8	512	120	1.6	0.00
P-180	4	343	120	0.0	0.00
P-181	2	484	120	1.4	0.01
P-182	6	155	120	0.2	0.00
P-183	6	353	120	1.4	0.00
P-184	6	670	120	1.0	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-185	8	160	120	1.3	0.00
P-186	6	130	120	2.1	0.00
P-187	8	190	120	0.0	0.00
P-188	6	521	120	0.7	0.00
P-189	10	170	120	0.3	0.00
P-190	6	231	120	1.1	0.00
P-191	6	92	120	0.9	0.00
P-192	8	623	120	0.4	0.00
P-193	6	368	120	0.4	0.00
P-194	8	757	120	2.3	0.00
P-195	6	244	120	1.0	0.00
P-196a	10	185	130	2.6	0.00
P-197a	10	216	130	2.8	0.00
P-198	8	268	120	1.5	0.00
P-199	8	749	120	0.5	0.00
P-200	6	344	120	0.7	0.00
P-201	2	876	120	0.1	0.00
P-202	6	435	120	0.8	0.00
P-203	8	130	120	0.0	0.00
P-204	8	303	120	0.3	0.00
P-205	6	287	120	1.9	0.00
P-206	8	275	120	0.4	0.00
P-208	6	16	120	2.2	0.00
P-209	8	49	120	0.7	0.00
P-210	8	136	120	0.1	0.00
P-211a	12	341	130	4.7	0.01
P-212a	14	28	130	0.1	0.00
P-213a	14	457	130	0.5	0.00
P-214	6	176	120	0.5	0.00
P-215	6	980	120	1.9	0.00
P-216	8	886	120	0.8	0.00
P-217	8	153	120	0.8	0.00
P-218	6	685	120	1.2	0.00
P-219	6	373	120	1.1	0.00
P-220	6	38	120	1.7	0.00
P-221	6	321	120	1.1	0.00
P-222	6	55	120	0.9	0.00
P-223	6	516	120	1.4	0.00
P-224	6	193	120	1.6	0.00
P-225	8	853	120	1.2	0.00
P-226	4	25	120	0.8	0.00
P-227	4	363	120	1.2	0.00
P-228	12	42	120	1.5	0.00
P-229	12	469	120	1.3	0.00
P-230	6	382	120	1.8	0.00
P-231	6	366	120	1.3	0.00
P-232	6	450	120	0.5	0.00
P-233	8	842	120	0.1	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-234	8	209	120	1.2	0.00
P-235	8	40	120	0.0	0.00
P-236	6	239	120	2.3	0.00
P-237	6	154	120	2.5	0.01
P-238a	12	58	130	1.0	0.00
P-239a	12	526	130	1.3	0.00
P-240a	12	157	130	0.9	0.00
P-241	8	53	120	2.0	0.00
P-242a	10	354	130	0.4	0.00
P-243a	10	362	130	0.4	0.00
P-244a	10	29	130	0.4	0.00
P-245a	10	154	130	1.7	0.00
P-246	8	268	120	0.1	0.00
P-247	6	331	120	1.5	0.00
P-248	6	370	120	1.0	0.00
P-249	6	315	120	1.6	0.00
P-250a	10	98	130	2.7	0.00
P-251	6	457	120	0.4	0.00
P-252	6	14	120	1.7	0.00
P-253	8	686	120	0.3	0.00
P-254	6	477	120	0.1	0.00
P-255	8	189	120	1.7	0.00
P-256	8	36	120	0.1	0.00
P-257a	12	244	130	4.2	0.01
P-258a	12	38	130	4.3	0.01
P-259a	10	684	130	1.7	0.00
P-260	8	236	120	0.2	0.00
P-261a	12	349	130	0.4	0.00
P-262	12	24	120	3.3	0.00
P-263	6	919	120	0.0	0.00
P-264	6	20	120	2.1	0.00
P-265	6	439	120	0.9	0.00
P-266	6	182	120	1.8	0.00
P-267	6	160	120	1.7	0.00
P-268	12	176	120	2.0	0.00
P-269	12	189	120	2.9	0.00
P-270	12	183	120	2.9	0.00
P-271	12	213	120	3.1	0.00
P-272	12	145	120	3.1	0.00
P-273	8	140	120	8.4	0.04
P-274	8	125	120	0.0	0.00
P-275	8	233	120	0.0	0.00
P-277	8	206	120	8.4	0.04
P-278	8	125	120	0.0	0.00
P-279	8	124	120	0.0	0.00
P-281	6	416	120	0.5	0.00
P-282	8	51	120	3.5	0.01
P-284	6	734	120	0.3	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-285	8	455	120	0.1	0.00
P-286	6	807	120	0.1	0.00
P-287	8	727	120	1.1	0.00
P-288	8	701	120	0.2	0.00
P-289	8	247	120	0.5	0.00
P-290a	10	263	130	0.4	0.00
P-291	6	252	120	0.1	0.00
P-292	6	244	120	0.1	0.00
P-293	8	734	130	0.7	0.00
P-298	16	445	130	2.1	0.00
P-299	12	315	120	0.7	0.00
P-300	12	363	120	0.7	0.00
P-301	8	907	120	0.4	0.00
P-302	6	211	120	0.5	0.00
P-303	8	305	120	0.1	0.00
P-304	8	299	120	0.1	0.00
P-305	6	217	120	0.8	0.00
P-306	8	339	120	1.9	0.00
P-307	8	350	120	1.9	0.00
P-308	8	184	130	0.0	0.00
P-309	8	272	130	0.0	0.00
P-310	8	476	130	0.1	0.00
P-311	8	269	130	0.1	0.00
P-312	6	510	120	0.0	0.00
P-313	8	105	120	0.1	0.00
P-314	6	309	120	0.8	0.00
P-315	6	345	120	1.6	0.00
P-316	6	207	130	0.8	0.00
P-317	8	262	120	1.7	0.00
P-318	8	276	130	0.0	0.00
P-319	8	259	120	1.7	0.00
P-320	8	278	130	0.1	0.00
P-321	8	320	120	1.3	0.00
P-322	8	1,220	120	1.5	0.00
P-323	8	405	130	0.7	0.00
P-324	8	610	120	0.0	0.00
P-325	8	184	120	0.6	0.00
P-326	12	397	130	0.2	0.00
P-327	8	303	130	2.3	0.00
P-328	8	212	130	0.0	0.00
P-329	8	304	130	2.2	0.00
P-330	8	299	130	1.0	0.00
P-331	8	267	130	1.0	0.00
P-332	8	261	130	1.1	0.00
P-333	8	257	130	0.2	0.00
P-334	8	259	130	0.1	0.00
P-335	8	280	130	0.4	0.00
P-336	8	256	130	0.0	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-337	8	604	130	0.2	0.00
P-338	8	267	130	0.3	0.00
P-339	8	255	130	0.1	0.00
P-340	8	255	130	0.0	0.00
P-341	8	514	130	0.1	0.00
P-342	8	303	130	0.1	0.00
P-343	8	516	130	0.0	0.00
P-344	8	264	130	0.1	0.00
P-345	8	519	130	0.1	0.00
P-346	8	255	130	0.3	0.00
P-347	8	281	130	0.8	0.00
P-348	8	369	130	0.5	0.00
P-349	8	597	130	0.1	0.00
P-350	8	256	130	0.1	0.00
P-351	8	266	130	0.1	0.00
P-352	8	595	130	0.3	0.00
P-353	8	182	130	0.3	0.00
P-354	8	185	130	0.1	0.00
P-355	8	365	130	0.5	0.00
P-356	8	126	130	0.6	0.00
P-357	8	368	130	0.6	0.00
P-358	8	262	130	0.8	0.00
P-359	8	263	130	1.0	0.00
P-360	8	233	130	1.1	0.00
P-361	8	527	130	0.2	0.00
P-362	8	270	130	0.7	0.00
P-363	8	112	130	0.4	0.00
P-364	8	379	130	0.4	0.00
P-365	8	264	130	0.1	0.00
P-366	8	597	130	0.0	0.00
P-367	8	373	120	0.9	0.00
P-368	8	639	120	1.5	0.00
P-369	8	182	130	0.6	0.00
P-370	8	325	130	0.1	0.00
P-371	8	192	130	0.4	0.00
P-372	8	305	130	0.2	0.00
P-373	8	285	130	0.1	0.00
P-374	8	701	130	0.1	0.00
P-375	8	479	130	0.1	0.00
P-376	8	249	130	0.3	0.00
P-377	8	587	130	0.5	0.00
P-378	8	129	130	0.2	0.00
P-379	8	622	130	0.3	0.00
P-380	8	670	130	0.3	0.00
P-381	8	96	130	0.3	0.00
P-382	8	465	130	0.2	0.00
P-383	8	165	130	0.1	0.00
P-384	8	126	130	0.2	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-385	8	266	130	0.0	0.00
P-386	8	264	130	0.2	0.00
P-387	8	598	130	1.1	0.00
P-388	4	281	130	0.4	0.00
P-389	8	528	130	0.1	0.00
P-390	8	286	130	0.1	0.00
P-391	6	328	130	0.1	0.00
P-392	8	366	130	0.6	0.00
P-393	8	191	130	1.7	0.00
P-394	8	390	130	2.1	0.00
P-395	8	173	130	0.4	0.00
P-396	8	260	130	1.3	0.00
P-397	8	239	130	1.6	0.00
P-398	8	382	130	0.9	0.00
P-399	8	249	130	1.2	0.00
P-400	8	253	130	1.8	0.00
P-401	8	171	130	2.9	0.00
P-402	8	381	130	1.0	0.00
P-403	8	381	130	0.5	0.00
P-404	8	542	130	0.3	0.00
P-405	8	377	130	2.4	0.00
P-406	8	328	130	0.2	0.00
P-407	8	649	120	0.1	0.00
P-408	8	541	120	0.0	0.00
P-409	8	420	120	2.0	0.00
P-410	8	928	120	2.2	0.00
P-411	8	462	120	0.7	0.00
P-412	8	770	120	0.7	0.00
P-413	8	470	120	0.8	0.00
P-414	8	461	120	0.8	0.00
P-415	6	578	120	0.5	0.00
P-416	6	381	120	0.7	0.00
P-417	8	463	130	0.5	0.00
P-418	8	392	130	0.4	0.00
P-419	8	1,305	130	0.4	0.00
P-420	8	1,418	130	0.4	0.00
P-421	8	192	130	1.2	0.00
P-422	8	204	130	1.2	0.00
P-423	6	521	120	0.0	0.00
P-424	6	416	120	0.0	0.00
P-425	8	264	130	0.1	0.00
P-426	8	267	130	0.1	0.00
P-427	8	342	130	0.0	0.00
P-428	8	541	130	0.1	0.00
P-429	8	259	130	0.2	0.00
P-430	8	263	130	0.1	0.00
P-431	8	411	130	0.1	0.00
P-432	8	271	130	0.0	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-433	8	368	130	0.1	0.00
P-434	8	261	130	0.1	0.00
P-435	8	254	130	0.1	0.00
P-436	8	542	130	0.0	0.00
P-437	8	257	130	0.1	0.00
P-438	8	201	130	0.3	0.00
P-439	8	339	130	0.3	0.00
P-440	8	258	130	0.1	0.00
P-441	8	596	130	0.0	0.00
P-442	8	267	130	0.0	0.00
P-443	8	600	130	0.1	0.00
P-444	8	596	130	0.3	0.00
P-445	8	269	130	0.1	0.00
P-446	10	482	130	1.8	0.00
P-447	12	918	130	2.1	0.00
P-448	8	408	130	0.1	0.00
P-449	8	749	130	0.0	0.00
P-450	8	280	130	0.0	0.00
P-451	8	291	130	0.0	0.00
P-452	8	416	130	0.0	0.00
P-453	8	112	130	0.0	0.00
P-454	8	391	130	0.0	0.00
P-455	8	90	130	0.1	0.00
P-456	8	269	130	0.1	0.00
P-457	8	370	130	0.1	0.00
P-458	8	318	130	0.0	0.00
P-459	8	276	130	0.0	0.00
P-460	8	253	130	0.1	0.00
P-461	8	318	130	0.0	0.00
P-462	8	543	130	0.1	0.00
P-463	8	261	130	0.2	0.00
P-464	8	257	130	0.1	0.00
P-465	8	334	130	0.1	0.00
P-466	8	336	130	0.0	0.00
P-467	8	241	130	0.1	0.00
P-468	10	1,159	130	2.0	0.00
P-472	6	396	130	22.7	0.27
P-473	8	252	130	0.4	0.00
P-475	8	208	130	0.8	0.00
P-476	8	663	130	0.9	0.00
P-477	8	497	130	0.1	0.00
P-478	8	364	130	0.1	0.00
P-479	8	142	130	0.3	0.00
P-480	10	707	130	0.1	0.00
P-481	10	297	130	0.0	0.00
P-484	10	540	130	2.7	0.00
P-486	14	1,298	130	1.0	0.00
P-487	14	1,559	130	0.4	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-488	14	1,131	130	0.2	0.00
P-489	14	2,265	130	1.8	0.00
P-490	14	992	130	0.6	0.00
P-491	14	731	130	0.1	0.00
P-492	14	548	130	0.3	0.00
P-493	14	962	130	3.3	0.00
P-494	14	887	130	2.7	0.00
P-495	14	1,112	130	2.2	0.00
P-496	14	1,722	130	0.1	0.00
P-497	14	1,232	130	1.4	0.00
P-498	14	371	130	1.6	0.00
P-499	14	215	130	2.5	0.00
P-501	12	1,140	130	0.8	0.00
P-503	14	1,103	130	2.7	0.00
P-504	14	505	130	1.3	0.00
P-505	14	704	130	0.9	0.00
P-508	14	1,625	130	0.2	0.00
P-509	14	966	130	0.7	0.00
P-510	14	1,293	130	1.8	0.00
P-511	14	1,859	130	3.3	0.00
P-512	12	780	130	1.9	0.00
P-513	12	1,265	130	0.1	0.00
P-514	12	331	130	0.3	0.00
P-515	12	1,858	130	1.1	0.00
P-516	12	374	130	1.0	0.00
P-517	12	145	130	0.3	0.00
P-519	12	62	130	0.2	0.00
P-520	12	67	130	0.6	0.00
P-521	12	221	130	0.9	0.00
P-522	12	589	130	2.5	0.00
P-523	12	1,506	130	3.1	0.00
P-524	12	366	130	3.8	0.00
P-525	12	970	130	1.5	0.00
P-526	12	859	130	1.1	0.00
P-532	12	128	130	0.7	0.00
P-540	12	677	130	2.8	0.00
P-541	12	584	130	2.7	0.00
P-542	12	262	130	2.2	0.00
P-544	8	635	130	1.4	0.00
P-545	12	311	130	1.7	0.00
P-547	12	122	130	0.5	0.00
P-548	12	213	130	1.3	0.00
P-562	14	86	130	0.5	0.00
P-565	12	123	130	0.5	0.00
P-569	10	536	130	1.2	0.00
P-570	10	1,354	130	1.5	0.00
P-571	10	1,370	130	2.1	0.00
P-572	10	2,469	130	3.0	0.00

Buildout Water System - City of Live Oak

Pipe Report - MDD

Label	Diameter (in)	Length (ft)	Hazen-Williams C	Velocity (ft/s)	Head loss Gradient (ft/1,000 ft)
P-600	12	83	130	5.7	0.01
P-601	12	96	130	5.7	0.01
P-602	12	88	130	5.7	0.01
P-620	8	510	130	1.0	0.00
P-621	20	58	130	3.9	0.00
P-622	20	86	130	3.9	0.00
P-623	20	38	130	2.0	0.00
P-624	12	146	130	5.7	0.01
P-627	12	110	130	5.7	0.01
P-628	6	105	130	0.0	0.00
P-629	6	76	130	0.0	0.00
P-632	6	69	130	6.9	0.03
P-633	6	93	130	6.9	0.03
P-634	20	41	130	2.0	0.00
P-635	8	848	130	3.5	0.01
P-636	8	606	130	1.4	0.00
P-637	12	131	130	5.7	0.01
P-638	14	807	130	2.4	0.00
P-639	12	1,229	130	1.1	0.00
P-640	12	673	130	0.5	0.00
P-641	12	1,512	130	0.1	0.00
P-642	12	602	130	0.6	0.00
P-643	12	2,278	130	0.1	0.00
P-644	12	361	130	0.5	0.00
P-645	12	290	130	0.4	0.00
P-646	12	319	130	2.8	0.00
P-647	10	284	130	2.1	0.00
P-648	12	1,397	130	0.1	0.00
P-649	12	1,112	130	1.3	0.00
P-650	20	139	130	2.0	0.00
P-651	10	1,399	130	0.5	0.00
P-652	12	151	130	5.7	0.01
P-653	12	1,018	130	0.0	0.00
P-654	12	69	130	0.0	0.00

Note: The pipe recommended to be paralleled or replaced IS labeled with the name as the existing pipe with an additional suffix "a".

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-1	3,000	3,799	TRUE	J-5	47.3
J-2	3,000	4,500	TRUE	J-218	41.6
J-3	3,000	4,500	TRUE	J-218	34.1
J-4	1,500	4,231	TRUE	J-11	20.0
J-5	1,500	4,500	TRUE	J-1	33.4
J-6	3,000	4,500	TRUE	J-316	48.7
J-7	1,500	4,500	TRUE	J-11	28.6
J-8	1,500	3,035	TRUE	J-9	20.0
J-9	1,500	2,420	TRUE	J-8	39.1
J-11	1,500	2,557	TRUE	J-4	53.3
J-12	1,500	3,843	TRUE	J-324	22.6
J-13	1,500	3,900	TRUE	J-9	30.9
J-14	3,000	4,500	TRUE	J-15	51.1
J-15	3,000	4,500	TRUE	J-14	51.4
J-16	3,000	4,500	TRUE	J-119	52.5
J-17	1,500	4,500	TRUE	J-217	32.4
J-18	1,500	2,817	TRUE	J-239	20.0
J-19	1,500	1,885	TRUE	J-20	20.0
J-20	1,500	1,820	TRUE	J-19	23.6
J-21	1,500	2,101	TRUE	J-20	20.0
J-22	1,500	3,838	TRUE	J-20	20.0
J-23	1,500	3,803	TRUE	J-24	20.0
J-24	1,500	3,665	TRUE	J-23	23.7
J-25	4,000	4,500	TRUE	J-342	68.7
J-26	4,000	4,500	TRUE	J-135	67.8
J-27	1,500	4,228	TRUE	J-29	44.0
J-28	1,500	4,177	TRUE	J-29	36.5
J-29	1,500	3,795	TRUE	J-216	27.0
J-30	1,500	4,241	TRUE	J-162	36.0
J-31	1,500	2,025	TRUE	J-32	58.2
J-32	1,500	3,663	TRUE	J-31	20.0
J-33	1,500	4,500	TRUE	J-32	49.1
J-34	1,500	4,500	TRUE	J-221	37.2
J-35	3,000	4,500	TRUE	J-139	61.9
J-36	3,000	4,500	TRUE	J-46	61.0
J-37	1,500	4,500	TRUE	J-252	52.9
J-38	1,500	2,532	TRUE	J-39	66.1
J-39	1,500	4,500	TRUE	J-38	47.3
J-40	1,500	4,500	TRUE	J-137	61.0
J-41	1,500	4,401	TRUE	J-160	27.6
J-42	1,500	4,500	TRUE	J-206	22.8
J-43	1,500	4,500	TRUE	J-42	30.4
J-44	1,500	4,500	TRUE	J-43	51.2
J-45	1,500	4,500	TRUE	J-44	57.7
J-46	1,500	4,500	TRUE	J-47	60.3
J-47	2,500	4,500	TRUE	J-52	60.3
J-48	1,500	3,594	TRUE	J-51	23.4

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-49	1,500	2,833	TRUE	J-51	20.0
J-50	3,000	4,500	TRUE	J-222	32.3
J-51	1,500	2,145	TRUE	J-49	41.7
J-53	3,000	4,500	TRUE	J-60	55.4
J-54	1,500	4,500	TRUE	J-53	56.8
J-55	1,500	4,500	TRUE	J-54	57.6
J-56	1,500	4,500	TRUE	J-193	57.3
J-57	1,500	4,500	TRUE	J-58	51.9
J-58	1,500	4,500	TRUE	J-59	49.4
J-59	1,500	4,500	TRUE	J-76	48.6
J-60	3,000	4,500	TRUE	J-61	50.5
J-61	3,000	4,500	TRUE	J-65	47.5
J-62	1,500	4,500	TRUE	J-63	45.2
J-63	1,500	4,500	TRUE	J-73	43.1
J-64	2,500	4,500	TRUE	J-66	47.9
J-65	3,000	4,500	TRUE	J-396	48.3
J-66	3,000	4,500	TRUE	J-259	43.1
J-67	2,500	4,500	TRUE	J-396	34.9
J-68	2,500	4,500	TRUE	J-396	40.7
J-69	1,500	4,500	TRUE	J-70	37.3
J-70	1,500	4,500	TRUE	J-69	37.9
J-71	1,500	4,500	TRUE	J-300	37.3
J-72	1,500	4,500	TRUE	J-73	37.2
J-73	1,500	2,412	TRUE	J-72	62.1
J-74	1,500	4,500	TRUE	J-77	42.0
J-75	1,500	4,500	TRUE	J-77	22.6
J-76	1,500	4,500	TRUE	J-74	47.3
J-77	1,500	2,405	TRUE	J-75	57.4
J-78	1,500	4,500	TRUE	J-76	49.6
J-79	1,500	4,500	TRUE	J-78	52.1
J-80	3,000	4,500	TRUE	J-150	55.9
J-81	3,000	3,776	TRUE	J-82	52.2
J-82	3,000	4,500	TRUE	J-81	39.7
J-83	2,500	4,500	TRUE	J-84	40.8
J-84	1,500	4,500	TRUE	J-345	40.5
J-85	1,500	4,500	TRUE	J-345	41.7
J-86	1,500	4,500	TRUE	J-343	43.7
J-87	1,500	2,400	TRUE	J-195	59.6
J-88	1,500	4,500	TRUE	J-205	43.8
J-89	1,500	4,500	TRUE	J-204	46.7
J-90	1,500	4,500	TRUE	J-245	61.7
J-91	1,500	4,500	TRUE	J-92	51.2
J-92	1,500	4,003	TRUE	J-247	20.1
J-93	1,500	4,440	TRUE	J-248	20.1
J-94	1,500	4,500	TRUE	J-93	42.6
J-95	1,500	4,500	TRUE	J-246	53.4
J-96	1,500	4,500	TRUE	J-97	65.8

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-97	2,500	4,500	TRUE	J-321	65.6
J-98	3,000	4,500	TRUE	J-321	62.0
J-99	1,500	3,669	TRUE	J-100	23.3
J-100	1,500	2,808	TRUE	J-99	46.3
J-101	1,500	3,974	TRUE	J-321	20.0
J-102	1,500	4,500	TRUE	J-103	37.9
J-103	1,500	4,500	TRUE	J-106	34.9
J-104	1,500	4,441	TRUE	J-374	23.2
J-105	1,500	3,293	TRUE	J-106	40.3
J-106	1,500	4,283	TRUE	J-105	20.0
J-107	1,500	3,832	TRUE	J-110	20.0
J-108	1,500	3,703	TRUE	J-303	21.7
J-109	1,500	2,733	TRUE	J-107	44.4
J-110	1,500	2,062	TRUE	J-107	56.7
J-111	1,500	2,129	TRUE	J-106	59.2
J-112	1,500	3,849	TRUE	J-115	41.2
J-113	1,500	4,500	TRUE	J-114	27.7
J-114	1,500	2,875	TRUE	J-113	54.0
J-115	1,500	4,500	TRUE	J-112	30.1
J-116	2,500	4,500	TRUE	J-117	36.6
J-117	2,500	4,500	TRUE	J-116	36.6
J-118	3,000	4,500	TRUE	J-117	44.3
J-119	1,500	3,083	TRUE	J-16	64.2
J-120	1,500	4,500	TRUE	J-233	35.1
J-121	2,500	4,500	TRUE	J-118	48.0
J-122	3,000	4,500	TRUE	J-219	60.6
J-123	3,000	4,500	TRUE	J-122	60.9
J-124	1,500	4,500	TRUE	J-126	58.8
J-125	3,000	4,500	TRUE	J-124	59.2
J-126	3,000	4,500	TRUE	J-124	58.8
J-127	3,000	4,461	TRUE	J-219	32.9
J-128	3,000	4,500	TRUE	J-129	61.2
J-130	1,500	4,500	TRUE	J-131	50.1
J-131	1,500	1,924	TRUE	J-130	71.7
J-132	1,500	4,500	TRUE	J-220	57.1
J-133	3,000	4,500	TRUE	J-132	67.5
J-134	4,000	4,500	TRUE	J-212	67.8
J-135	4,000	4,500	TRUE	J-32	67.5
J-136	4,000	4,500	TRUE	J-234	67.5
J-137	1,500	4,500	TRUE	J-33	53.8
J-139	3,000	4,500	TRUE	J-138	59.8
J-140	3,000	4,500	TRUE	J-36	61.3
J-141	3,000	3,688	TRUE	J-210	31.3
J-142	2,500	4,500	TRUE	J-190	55.7
J-143	1,500	4,500	TRUE	J-146	54.8
J-144	1,500	4,286	TRUE	J-190	20.0
J-145	2,500	4,500	TRUE	J-190	40.5

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-146	2,500	4,500	TRUE	J-143	56.1
J-147	1,500	2,231	TRUE	J-148	62.5
J-148	2,500	4,500	TRUE	J-147	27.9
J-149	2,500	4,500	TRUE	J-147	42.2
J-150	1,500	4,500	TRUE	J-149	49.5
J-151	2,500	4,406	TRUE	J-152	44.7
J-152	1,500	4,500	TRUE	J-151	43.2
J-153	1,500	4,500	TRUE	J-235	55.0
J-154	1,500	2,315	TRUE	J-155	55.9
J-155	1,500	3,533	TRUE	J-154	35.0
J-156	1,500	4,243	TRUE	J-302	20.0
J-157	1,500	2,183	TRUE	J-206	42.3
J-158	1,500	1,983	TRUE	J-207	40.1
J-159	1,500	2,544	TRUE	J-208	20.0
J-161	2,500	3,699	TRUE	J-160	20.0
J-162	1,500	3,470	TRUE	J-163	20.0
J-163	1,500	2,227	TRUE	J-162	51.3
J-164	1,500	4,213	TRUE	J-253	50.3
J-165	3,000	4,500	TRUE	J-166	67.9
J-166	3,000	4,500	TRUE	J-129	67.8
J-167	3,000	4,500	TRUE	J-305	68.0
J-168	3,000	4,500	TRUE	J-249	66.0
J-169	3,000	4,500	TRUE	J-305	67.9
J-170	1,500	4,500	TRUE	J-305	68.0
J-171	1,500	4,500	TRUE	J-96	67.1
J-172	1,500	4,500	TRUE	J-305	68.1
J-173	3,000	4,500	TRUE	J-174	44.4
J-176	3,000	4,500	TRUE	J-175	41.6
J-177	3,000	4,500	TRUE	J-178	49.6
J-178	3,000	4,500	TRUE	J-258	49.3
J-179	1,500	4,500	TRUE	J-409	71.0
J-180	1,500	4,500	TRUE	J-409	71.0
J-181	1,500	4,500	TRUE	J-417	69.6
J-182	1,500	1,191	FALSE	J-325	41.4
J-183	1,500	3,607	TRUE	J-213	55.8
J-184	1,500	4,500	TRUE	J-185	46.1
J-185	1,500	4,500	TRUE	J-184	46.1
J-186	1,500	4,500	TRUE	J-187	45.5
J-187	1,500	4,500	TRUE	J-186	45.4
J-188	4,000	4,500	TRUE	J-25	70.6
J-189	1,500	2,994	TRUE	J-325	20.0
J-190	2,500	3,262	TRUE	J-144	42.1
J-191	2,500	3,096	TRUE	J-192	20.0
J-193	1,500	4,500	TRUE	J-191	49.0
J-194	1,500	4,500	TRUE	J-87	41.9
J-195	2,000	4,500	TRUE	J-87	24.7
J-196	1,500	4,500	TRUE	J-344	45.7

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-197	2,500	4,500	TRUE	J-194	43.8
J-199	3,000	4,500	TRUE	J-142	55.5
J-200	1,500	4,500	TRUE	J-95	58.2
J-201	1,500	4,500	TRUE	J-229	50.7
J-202	3,000	4,067	TRUE	J-141	50.4
J-203	1,500	4,500	TRUE	J-200	57.8
J-204	1,500	4,500	TRUE	J-285	43.1
J-205	1,500	2,852	TRUE	J-88	61.4
J-206	1,500	2,900	TRUE	J-157	20.0
J-207	1,500	2,547	TRUE	J-158	20.0
J-208	1,500	1,669	TRUE	J-159	49.4
J-209	3,000	4,500	TRUE	J-52	57.2
J-210	3,000	4,170	TRUE	J-141	20.0
J-211	1,500	4,500	TRUE	J-246	45.5
J-212	1,500	4,500	TRUE	J-164	51.9
J-213	1,500	4,500	TRUE	J-183	44.4
J-215	1,500	3,031	TRUE	J-325	29.7
J-216	1,500	3,257	TRUE	J-215	29.1
J-217	1,500	3,268	TRUE	J-239	25.3
J-218	1,500	2,230	TRUE	J-3	64.9
J-221	1,500	4,309	TRUE	J-34	42.7
J-222	1,500	3,297	TRUE	J-48	44.6
J-223	2,500	4,500	TRUE	J-419	36.7
J-224	1,500	4,245	TRUE	J-154	20.0
J-225	1,500	4,500	TRUE	J-255	59.9
J-226	3,000	4,500	TRUE	J-100	66.6
J-227	1,500	3,669	TRUE	J-228	33.3
J-228	4,000	3,918	FALSE	J-227	26.9
J-229	3,000	4,500	TRUE	J-201	51.1
J-230	3,000	4,500	TRUE	J-139	63.4
J-231	1,500	4,500	TRUE	J-198	50.0
J-232	3,000	4,500	TRUE	J-305	68.1
J-233	1,500	4,500	TRUE	J-12	33.9
J-234	4,000	4,500	TRUE	J-136	67.6
J-235	1,500	4,500	TRUE	J-153	55.3
J-236	3,000	4,500	TRUE	J-10	51.5
J-237	3,000	4,500	TRUE	J-305	68.4
J-238	1,500	4,500	TRUE	J-45	58.7
J-245	1,500	4,500	TRUE	J-225	61.0
J-246	1,500	4,291	TRUE	J-211	49.5
J-247	1,500	3,044	TRUE	J-92	42.0
J-248	1,500	3,244	TRUE	J-93	44.3
J-249	3,000	4,500	TRUE	J-201	55.9
J-250	1,500	1,912	TRUE	J-20	20.9
J-251	1,500	2,001	TRUE	J-250	20.7
J-252	1,500	4,500	TRUE	J-37	53.8
J-253	1,500	4,500	TRUE	J-164	44.2

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-254	1,500	4,500	TRUE	J-255	41.5
J-255	1,500	3,976	TRUE	J-254	48.2
J-256	1,500	4,500	TRUE	J-257	34.2
J-257	1,500	3,752	TRUE	J-256	45.6
J-258	1,500	4,500	TRUE	J-23	45.1
J-259	3,000	4,500	TRUE	J-66	43.2
J-260	1,500	4,500	TRUE	J-262	60.0
J-261	1,500	4,500	TRUE	J-262	44.8
J-262	1,500	4,392	TRUE	J-261	46.1
J-263	1,500	4,500	TRUE	J-291	44.8
J-264	1,500	4,500	TRUE	J-265	44.0
J-265	1,500	4,500	TRUE	J-264	43.7
J-266	1,500	4,500	TRUE	J-280	43.2
J-267	1,500	4,500	TRUE	J-346	43.2
J-268	1,500	4,500	TRUE	J-346	43.2
J-269	1,500	4,500	TRUE	J-292	41.0
J-270	1,500	4,500	TRUE	J-271	41.4
J-271	1,500	4,500	TRUE	J-281	38.0
J-272	1,500	4,500	TRUE	J-279	35.4
J-273	1,500	4,500	TRUE	J-274	34.4
J-274	1,500	4,500	TRUE	J-275	31.4
J-275	1,500	4,500	TRUE	J-278	23.3
J-276	1,500	4,500	TRUE	J-279	24.2
J-277	1,500	4,047	TRUE	J-279	20.0
J-278	1,500	4,077	TRUE	J-279	28.6
J-279	1,500	2,750	TRUE	J-277	47.0
J-280	1,500	4,500	TRUE	J-292	31.3
J-281	1,500	4,500	TRUE	J-282	36.9
J-282	1,500	4,500	TRUE	J-281	37.1
J-283	1,500	4,500	TRUE	J-282	39.1
J-284	1,500	4,500	TRUE	J-322	37.9
J-285	1,500	4,500	TRUE	J-204	42.8
J-286	1,500	4,500	TRUE	J-285	44.0
J-287	1,500	4,500	TRUE	J-288	34.9
J-288	1,500	4,500	TRUE	J-287	34.8
J-289	1,500	4,500	TRUE	J-288	46.2
J-290	1,500	4,500	TRUE	J-291	44.6
J-291	1,500	4,500	TRUE	J-290	44.8
J-292	1,500	4,500	TRUE	J-280	31.4
J-293	1,500	4,500	TRUE	J-289	48.7
J-294	1,500	4,492	TRUE	J-301	20.0
J-295	1,500	4,500	TRUE	J-301	29.6
J-296	1,500	4,500	TRUE	J-297	31.4
J-297	1,500	4,500	TRUE	J-298	24.9
J-298	2,500	3,907	TRUE	J-299	35.7
J-299	2,500	4,500	TRUE	J-298	24.5
J-300	2,500	4,500	TRUE	J-299	35.0

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-301	1,500	3,997	TRUE	J-294	30.1
J-302	1,500	3,586	TRUE	J-156	34.0
J-303	1,500	3,619	TRUE	J-310	20.1
J-304	1,500	3,503	TRUE	J-307	20.1
J-305	1,500	3,450	TRUE	J-311	20.2
J-306	1,500	3,580	TRUE	J-324	26.3
J-308	1,500	2,541	TRUE	J-304	43.5
J-309	1,500	2,939	TRUE	J-303	36.7
J-310	1,500	1,950	TRUE	J-303	56.6
J-311	1,500	2,691	TRUE	J-305	39.2
J-312	1,500	4,500	TRUE	J-5	46.2
J-313	1,500	4,500	TRUE	J-319	54.3
J-314	1,500	4,500	TRUE	J-315	50.3
J-315	1,500	4,500	TRUE	J-320	46.9
J-316	1,500	4,500	TRUE	J-320	44.8
J-317	1,500	4,500	TRUE	J-320	34.1
J-318	1,500	4,500	TRUE	J-320	44.1
J-319	1,500	4,500	TRUE	J-318	50.2
J-320	1,500	3,048	TRUE	J-317	54.9
J-321	1,500	3,070	TRUE	J-101	41.1
J-322	1,500	3,393	TRUE	J-323	44.2
J-323	1,500	3,857	TRUE	J-322	36.0
J-324	1,500	3,683	TRUE	J-306	22.7
J-325	1,500	1,517	TRUE	J-182	20.0
J-326	1,500	4,500	TRUE	J-283	39.8
J-327	1,500	4,500	TRUE	J-336	41.0
J-328	1,500	4,500	TRUE	J-329	42.2
J-329	1,500	4,500	TRUE	J-330	41.0
J-330	1,500	4,500	TRUE	J-331	35.2
J-331	1,500	4,450	TRUE	J-352	22.6
J-332	1,500	4,500	TRUE	J-333	33.5
J-333	1,500	4,443	TRUE	J-351	23.2
J-334	1,500	4,500	TRUE	J-355	37.0
J-335	1,500	4,500	TRUE	J-338	41.0
J-336	1,500	4,500	TRUE	J-327	40.9
J-337	1,500	4,500	TRUE	J-347	39.4
J-338	1,500	4,500	TRUE	J-354	37.6
J-339	1,500	4,500	TRUE	J-369	60.1
J-340	1,500	4,500	TRUE	J-428	53.0
J-341	3,000	4,500	TRUE	J-233	44.5
J-342	1,500	4,120	TRUE	J-20	28.2
J-343	1,500	4,475	TRUE	J-84	42.1
J-344	1,500	4,500	TRUE	J-83	44.0
J-345	1,500	3,091	TRUE	J-84	58.6
J-346	1,500	4,500	TRUE	J-268	43.8
J-347	1,500	4,399	TRUE	J-348	34.5
J-348	1,500	4,340	TRUE	J-349	33.5

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-349	1,500	4,500	TRUE	J-348	29.4
J-350	1,500	4,500	TRUE	J-351	32.3
J-351	1,500	4,420	TRUE	J-333	23.8
J-352	1,500	4,431	TRUE	J-331	23.1
J-353	1,500	4,500	TRUE	J-350	33.4
J-354	1,500	4,500	TRUE	J-338	38.6
J-355	1,500	4,500	TRUE	J-334	37.6
J-356	1,500	4,500	TRUE	J-357	35.0
J-357	1,500	4,500	TRUE	J-360	35.3
J-358	1,500	4,500	TRUE	J-323	37.3
J-359	1,500	4,500	TRUE	J-355	37.1
J-360	1,500	4,500	TRUE	J-353	34.1
J-361	1,500	4,500	TRUE	J-369	50.4
J-368	1,500	3,062	TRUE	J-403	64.9
J-369	1,500	4,388	TRUE	J-361	51.6
J-370	1,500	4,436	TRUE	J-371	47.3
J-371	1,500	4,500	TRUE	J-370	46.6
J-372	1,500	4,456	TRUE	J-373	31.6
J-373	1,500	4,237	TRUE	J-374	31.6
J-374	1,500	4,334	TRUE	J-104	26.1
J-375	1,500	4,500	TRUE	J-370	50.6
J-377	1,500	4,500	TRUE	J-401	55.6
J-378	1,500	4,500	TRUE	J-379	58.8
J-379	1,500	4,500	TRUE	J-380	57.4
J-380	3,000	4,500	TRUE	J-381	57.1
J-381	3,000	4,500	TRUE	J-382	55.6
J-382	1,500	4,500	TRUE	J-383	47.0
J-383	3,000	4,500	TRUE	J-384	45.0
J-384	1,500	4,500	TRUE	J-429	43.1
J-385	1,500	4,500	TRUE	J-429	41.7
J-386	1,500	4,500	TRUE	J-429	37.9
J-387	1,500	4,500	TRUE	J-429	34.9
J-388	1,500	4,500	TRUE	J-429	31.6
J-389	1,500	4,500	TRUE	J-420	31.8
J-390	3,000	4,500	TRUE	J-420	34.9
J-391	3,000	4,500	TRUE	J-392	34.4
J-392	3,000	4,500	TRUE	J-431	34.5
J-393	3,000	4,500	TRUE	J-394	25.2
J-394	3,000	4,412	TRUE	J-395	22.1
J-395	3,000	4,349	TRUE	J-394	23.8
J-396	3,000	4,500	TRUE	J-441	28.9
J-397	1,500	4,500	TRUE	J-398	57.7
J-398	1,500	4,500	TRUE	J-399	56.1
J-399	3,000	4,500	TRUE	J-400	55.2
J-400	3,000	4,500	TRUE	J-401	53.4
J-401	1,500	4,500	TRUE	J-400	54.1
J-402	3,000	4,500	TRUE	J-403	64.1

Buildout Water System - City of Live Oak

Junction Report - MDD+FIRE

Label	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Satisfies Fire Flow Constraints?	Junction w/Minimum Pressure (Zone)	Calculated Minimum Zone Pressure (psi)
J-403	1,500	4,500	TRUE	J-368	56.3
J-404	3,000	4,500	TRUE	J-405	52.9
J-405	3,000	4,500	TRUE	J-404	52.8
J-406	3,000	4,500	TRUE	J-407	53.1
J-407	1,500	4,500	TRUE	J-408	45.7
J-408	1,500	4,500	TRUE	J-407	45.5
J-409	1,500	4,500	TRUE	J-410	41.2
J-410	3,000	4,500	TRUE	J-409	41.0
J-411	1,500	4,500	TRUE	J-409	42.3
J-412	1,500	4,500	TRUE	J-409	46.8
J-413	1,500	4,500	TRUE	J-409	49.7
J-414	1,500	4,500	TRUE	J-413	58.2
J-415	1,500	4,500	TRUE	J-414	60.7
J-416	1,500	4,500	TRUE	J-409	65.6
J-417	1,500	4,500	TRUE	J-443	69.4
J-418	1,500	4,500	TRUE	J-358	47.2
J-419	3,000	4,500	TRUE	J-393	34.6
J-420	3,000	4,500	TRUE	J-430	27.6
J-421	1,500	4,500	TRUE	J-429	23.7
J-422	1,500	4,500	TRUE	J-429	23.7
J-423	1,500	4,500	TRUE	J-429	34.9
J-424	1,500	4,500	TRUE	J-429	37.9
J-426	3,000	4,500	TRUE	J-409	52.1
J-427	1,500	4,500	TRUE	J-428	54.0
J-428	1,500	4,500	TRUE	J-340	52.9
J-429	1,500	4,354	TRUE	J-421	26.7
J-430	1,500	4,500	TRUE	J-420	27.3
J-431	1,500	4,500	TRUE	J-393	32.9
J-441	3,000	4,500	TRUE	J-396	29.2
J-442	3,000	4,379	TRUE	J-395	25.4
J-443	1,500	4,500	TRUE	J-417	69.2
J-444	1,500	4,500	TRUE	J-445	43.9
J-445	1,500	4,500	TRUE	J-446	38.5
J-446	1,500	4,500	TRUE	J-445	38.6

Appendix B

Water Connection Fee Analysis

ECO:LOGIC
ENGINEERS · CONSULTANTS

3875 Atherton Road
Rocklin, CA 95765
916.773.8100 TEL
916.773.8448 FAX

To: **Satwant Takhar, City of Live Oak**

From: **Georgette Aronow**

CC: **Michael Harrison, Cindy Bertsch**

Date: **November 23, 2009**

RE: **Revised Draft Water Connection Fee Analysis**

ECO:LOGIC is currently in the process of preparing the Water Master Plan for the City of Live Oak. As part of that analysis it was requested that the Wter Connection Fee and the AB 1600 Fee be updated.

This analysis calculates one fee that would replace both the current Water Connection Fee and the AB 1600 Fee. The fee calculated in this analysis will be referred to as the 2009 Connection Fee and includes three components:

1) ***System Buy-In***: The system buy-in charge based on the City's existing water infrastructure assets. The analysis is based on the total cost of all of the water assets at installation less accumulated depreciation. The asset value information is based on the City's water asset depreciation table, which is included as Appendix A.

2) ***Future CIP Project Costs***: The future CIP project costs are based on the projected facility needs as identified in the Water Master Plan. These costs were split between existing and future users based on benefit. The costs allocated to future users are included in the 2009 Water Connection Fee.

3) ***Meter Installation Costs***: The cost of installing and connecting a water meter to the City's distribution system is also included in the 2009 Water Connection Fee.

Each of these fee components and how they were computed are discussed in greater detail below. **Table 1** summarizes the calculated connection fee.

Table 1
City of Live Oak
Water Connection Fee Analysis
Summary of the Calculated 2009 Water Connection Fee

DRAFT

Meter Size	EDU Factor	Infrastructure: Existing Buy-in Charge	Infrastructure: Future CIP Costs	Meter Installation Costs	Subtotal Cost	Admin. Charge 1.50%	Total Connection Fee
Less than 1"	1.00	$682	$5,127	$1,480	$7,289	$109	$7,398
1"	1.67	$1,137	$8,544	$1,520	$11,202	$168	$11,370
1 1/2"	3.33	$2,274	$17,089	$1,720	$21,083	$316	$21,399
2"	5.33	$3,639	$27,342	$1,920	$32,901	$494	$33,394
3"	11.67	$7,961	$59,810	$3,700	$71,471	$1,072	$72,543
4"	21.00	$14,329	$107,658	$5,980	$127,967	$1,920	$129,887
6"	46.67	$31,842	$239,241	$8,020	$279,103	$4,187	$283,290

MAJOR ASSUMPTIONS

This analysis and calculation of the 2009 Water Connection fee is predicated on several major assumptions, discussed in further detail below.

EQUIVALENT DWELLING UNITS (EDUs)

For water service, one equivalent dwelling unit (EDU) is the amount of water an average single family residence is assumed to use. The Water Master Plan assumes that one EDU uses 500 gallons per day.

The total capacity added to the water system by future improvements is estimated at 7.4 million gallons per day (gpd). This capacity would serve approximately 14,800 future EDUs.

Total water sold in 2008 was approximately 469 million gallons. This equates to approximately 1.3 million gallons per day and 2,570 current (existing) EDUs, assuming 500 gpd per EDU.

Therefore, there is capacity for 17,370 EDUs to be serviced upon completion of water infrastructure improvements described in the Water Master Plan.

EDU FACTORS

EDU factors are the method for equating a single family unit to other types of customers, such as non-residential customers. In the case of water infrastructure, it is typical to use the water meter size as a way of establishing EDU factors. Each meter size has a maximum flow rate and can be equated

back to one EDU (a single family unit). The meter flow rates were determined based on the INVENSYS Catalog, the typical type of meter installed by the City of Live Oak. Those flow rates and EDU factors are shown in **Table 2**.

Table 2
City of Live Oak
Water Connection Fee Analysis
Proposed EDU Factors

Meter Size, in	Capacity (gpm) [1]	Proposed EDU Factor
Less than 1	30	1
1	50	1.7
1.5	100	3.3
2	160	5.3
3	350	11.7
4	630	21.0
6	1,400	46.7

[1] Based on INVENSYS Catalog

SYSTEM BUY-IN CHARGE

The system buy-in costs are based on an inventory of the City's existing water assets (water lines, wells, and water storage tank). The analysis uses the City's water asset depreciation schedule as the basis for this calculation and is included as Appendix A.

The total water assets are estimated at $14.33 million, based on estimated costs at installation. Of that $14.33 million, the City has accumulated approximately $2.48 million in depreciation. The remaining net value of the assets, is therefore, estimated at $11.85 million as shown in Table 3.

The $11.85 million represents the value of the assets to spread over both existing and future users. The total cost is divided by the total EDUs, estimated at 17,370, for a cost per EDU of $682.33.

Table 3
City of Live Oak
Water Connection Fee Analysis
Summary of the Buy-In-Cost Analysis

Utility	Estimated Cost at Installation	Est. Total Accumulated Depreciation	Buy-In Costs Net of Accumulated Depreciation
	Costs Rounded to Thousands of Dollars		
Water	$14,335,196	$2,483,191	$11,852,004
EDUs			
Existing			2,570
Future			14,800
Total			**17,370**
Cost per EDU			**$682.33**

FUTURE CIP COSTS

The future CIP costs represent the costs of future facilities to be built to serve new development. Table 4 shows the facilities and costs as identified by the Water Master Plan. These costs are then distributed to existing and future users based on benefit of the facilities. The majority of the costs, $49.38 million of the $55.14 million in total costs, are allocated to new development.

Table 4
City of Live Oak
Water Connection Fee Analysis
Summary of Water Master Plan Capital Improvement Costs and Allocation to Existing and New Users

Description	Master Plan Capital Cost	Cost Distribution Existing	Cost Distribution New	Cost Allocation Existing	Cost Allocation New
Water Pipeline Replacement/ Paralleling Projects	$1,870,000	100%	0%	$1,870,000	$0
Two 0.7 MG Tanks	$2,016,000	0%	100%	$0	$2,016,000
Two 230 HP Booster Pump Stations	$3,398,000	0%	100%	$0	$3,398,000
Nine Wells with Arsenic Treatment	$34,992,000	11%	89%	$3,888,000	$31,104,000
Distribution System Improvements	$12,860,000	0%	100%	$0	$12,860,000
Total	**$55,136,000**			**$5,758,000**	**$49,378,000**

It is likely that the City will have to finance these costs at some future date in order to move forward with construction. Therefore, Table 5 calculates the cost per EDU including a financing factor.

The financing factor included in this initial calculation does not represent the full cost of financing, if the City were to finance all of the projects today, which is not likely. The annualized debt service payments are discounted by 3.5 percent, to reflect that the City is not planning to build these projects immediately. This results in the interest cost being cut by a factor of 50 percent.

The new facilities will add approximately 7.4 million gallons of additional capacity. If the total cost by the additional capacity is divided by the total gallons of treated water, the cost per treated gallon is estimated at $10.25.

One EDU is assumed to use approximately 500 gallons per day. Therefore, the cost per EDU is calculated at $10.25 * 500 to equal $5,127 per EDU.

Table 5
City of Live Oak
Water Connection Fee Analysis
Water - New Capacity and Fee per EDU

DRAFT

ITEM	*Assumption*	TOTAL COST
Total Project Cost		$49,378,000
Financing Factor [1]	**0.54**	$26,495,563
TOTAL COST		**$75,873,563**
Additional Capacity Added (GPD) [2]		7,400,000
Cost per Gallon		**$10.25**
Gallons/Day per EDU		500
Cost per EDU [3]		**$5,127**

"cost_EDU"

[1] Assumes that 100 percent of the costs are financed:

Financing Costs:	
Amount Financed	$49,378,000.00
Rate	6.00%
Term	30
Bond Load Factor	15%
Annual Debt Service	$4,125,346.64
Total Debt Service	$123,760,399.33
Net Present Value of Debt Service 3.5% *discount factor*	$75,873,562.82
Net Proceeds	$49,378,000.00
Financing Cost	$26,495,562.82

[2] As determined by ECO:LOGIC
[3] Assumes that the Fee will be escalated by 3.5% each year.

METER INSTALLATION COST

Table 6 shows the City's estimated cost for installing a meter, by the various meter sizes. This cost is included in the fee amount. It includes both the capital cost and the labor cost for the meter installation.

Table 6
City of Live Oak
Water Connection Fee Analysis
Calculation of Water Meter Installation Cost by Meter Size

					Labor				Total
Meter Size	Meter	Box	Lid	Subtotal	Hours	Cost Per Hour	Labor Cost	Total	Rounded
Less than 1"	$143.23	$23.85	$30.97	$198.05	16.00	$80.00	$1,280.00	**$1,478.05**	**$1,480.00**
1"	$180.87	$23.85	$30.97	$235.69	16.00	$80.00	$1,280.00	**$1,515.69**	**$1,520.00**
1 1/2"	$377.04	$27.05	$35.61	$439.70	16.00	$80.00	$1,280.00	**$1,719.70**	**$1,720.00**
2"	$573.21	$30.25	$40.24	$643.70	16.00	$80.00	$1,280.00	**$1,923.70**	**$1,920.00**
3"	$1,695.00	$36.67	$45.05	$1,776.72	24.00	$80.00	$1,920.00	**$3,696.72**	**$3,700.00**
4"	$2,805.00	$127.74	$489.14	$3,421.88	32.00	$80.00	$2,560.00	**$5,981.88**	**$5,980.00**
6"	$4,845.00	$127.74	$489.14	$5,461.88	32.00	$80.00	$2,560.00	**$8,021.88**	**$8,020.00**

Note: Costs for a 3, 4 and 6 inch meter is for a compound meter.

These three cost components are added together to compute the 2009 Water Connection Fee as shown in Table 1 above.

OTHER RECOMMENDATIONS

It is recommended that the City establish in its ordinance, at the time of fee adoption, the ability to increase the fee by 3.5% annually, at a minimum. The annual increase could also be linked to consumer price index (CPI) or the ENR Construction Cost Index.

This is particularly important if the City does plan to move forward with financing any of the CIP projects. If the fee is inflated annually, then the City should be able to recuperate the majority of the financing costs over time. The annual adjustment will also allow the City to stay current as the actual costs of meter installation will likely increase over time.

The City should also consider reviewing and updating the fee analysis every three years, particularly since at this time the construction timing of the projects are unkown.

Appendix A

Water Asset Valuation

City of Live Oak

FUND: 012 - WATER ENTERPRISE FISCAL YEAR: 07/2009-06/2010

DATE ACQUIRED	DESCRIPTION	ID	TOTAL LIFE	TOTAL COST	SALVAGE VALUE	PRIOR PERIOD ACCUM DEPR	CURRENT PERIOD 07/2009-06/2010	NET VALUE
01/01/94	1994 GORMAN RUP	000018-00	60	10,000.00	0.00	10,000.00	0.00	0.00
01/01/51	WELL #1 OLD COR	000049-00	720	20,000.00	0.00	19,503.47	0.00	496.53
01/01/74	WELL #1 OLD COR	000049-01	240	10,000.00	0.00	10,000.00	0.00	0.00
01/01/77	WELL #1 OLD COR	000049-02	240	5,000.00	0.00	5,000.00	0.00	0.00
01/01/77	WELL #1 OLD COR	000049-03	180	1,500.00	0.00	1,500.00	0.00	0.00
01/01/51	WELL #1 OLD CO	000049-04	360	10,000.00	0.00	10,000.00	0.00	0.00
01/01/91	WILL #1 OLD CO	000049-05	180	2,000.00	0.00	2,000.00	0.00	0.00
01/01/91	WELL #1 OLD CO	000049-06	180	25,000.00	0.00	25,000.00	0.00	0.00
01/01/91	WELL #1 - OLD C	000049-07	180	500.00	0.00	500.00	0.00	0.00
01/01/91	WELL #1 OLD COR	000049-08	180	2,000.00	0.00	2,000.00	0.00	0.00
01/01/91	WELL #1 OLD COR	000049-09	180	3,159.75	0.00	3,159.75	0.00	0.00
02/23/93	10140 O STREET	000049-10	0	1,148.22	0.00	0.00	0.00	1,148.22
01/01/51	WELL #2 OLD COR	000050-00	720	20,000.00	0.00	19,503.47	0.00	496.53
02/02/95	WELL #2 OLD COR	000050-01	240	10,000.00	0.00	7,207.33	0.00	2,792.67
01/01/65	WELL #2 OLD COR	000050-02	240	5,000.00	0.00	5,000.00	0.00	0.00
01/01/77	WELL #2 OLD COR	000050-03	180	1,500.00	0.00	1,500.00	0.00	0.00
01/01/51	WELL #2 OLD COR	000050-04	360	10,000.00	0.00	10,000.00	0.00	0.00
08/26/91	WELL #2 OLD COR	000050-05	180	2,000.00	0.00	2,000.00	0.00	0.00
01/01/51	WELL #2 OLD COR	000050-06	180	3,159.75	0.00	3,159.75	0.00	0.00
01/01/91	WELL #2 OLD COR	000050-07	180	25,000.00	0.00	25,000.00	0.00	0.00
01/01/91	WELL #2 OLD COR	000050-08	180	2,000.00	0.00	2,000.00	0.00	0.00
02/23/92	10140 O STREET	000050-09	0	1,148.22	0.00	0.00	0.00	1,148.22
01/01/60	WELL #3 ALLEY B	000051-00	720	25,000.00	0.00	20,633.47	0.00	4,366.53
01/01/73	WELL #3 ALLEY B	000051-01	240	12,000.00	0.00	12,000.00	0.00	0.00
01/01/60	WELL #3 ALLEY W	000051-02	240	5,000.00	0.00	5,000.00	0.00	0.00
01/01/77	WELL #3 ALLEY B	000051-03	180	1,500.00	0.00	1,500.00	0.00	0.00
01/01/60	WELL #3 ALLEY B	000051-04	360	10,000.00	0.00	10,000.00	0.00	0.00
01/01/92	WELL #3 ALLEY B	000051-05	180	2,000.00	0.00	2,000.00	0.00	0.00
01/01/60	WELL #3 ALLEY B	000051-06	240	1,000.00	0.00	1,000.00	0.00	0.00
08/01/54	ARCHER AVE WELL	000051-07	0	237.92	0.00	0.00	0.00	237.92
01/01/83	WELL #4 APRICOT	000052-00	480	40,000.00	0.00	26,507.83	0.00	13,492.17
01/01/83	WELL #4 APRICOT	000052-01	240	20,000.00	0.00	20,000.00	0.00	0.00
01/01/83	WELL #4 APRICOT	000052-02	240	8,000.00	0.00	8,000.00	0.00	0.00
01/01/83	WELL #4 APRICOT	000052-03	180	5,000.00	0.00	5,000.00	0.00	0.00
01/01/83	WELL #4 APRICOT	000052-04	360	20,000.00	0.00	15,673.06	0.00	4,326.94
10/26/98	WELL #4 APRICOT	000052-05	180	3,000.00	0.00	2,135.12	0.00	864.88
12/30/98	WELL #4 APRICOT	000052-06	180	19,160.00	0.00	13,415.21	0.00	5,744.79
12/30/98	WELL #4 APRICOT	000052-07	180	3,340.00	0.00	2,338.57	0.00	1,001.43
10/27/95	2569 APRICOT ST	000052-08	0	30,000.00	0.00	0.00	0.00	30,000.00
01/01/83	WELL #5 PENNING	000053-00	480	40,000.00	0.00	26,507.83	0.00	13,492.17
01/01/83	WELL #5 PENNING	000053-01	240	20,000.00	0.00	20,000.00	0.00	0.00
01/01/83	WELL #5 PENNING	000053-02	240	8,000.00	0.00	8,000.00	0.00	0.00
01/01/83	WELL #5 PENNING	000053-03	180	5,000.00	0.00	5,000.00	0.00	0.00
01/01/83	WELL #5 PENNING	000053-04	360	20,000.00	0.00	17,670.05	0.00	2,329.95
10/26/98	WELL #5 PENNING	000053-05	180	3,225.63	0.00	2,295.67	0.00	929.96
12/30/98	WELL #5 PENNING	000053-06	180	19,160.00	0.00	13,415.21	0.00	5,744.79
12/30/98	WELL #5 PENNING	000053-07	180	3,340.00	0.00	2,338.57	0.00	1,001.43
10/01/48	WELL #5 PENNING	000053-08	0	172.78	0.00	0.00	0.00	172.78
01/01/51	WATER PIPES - 1	000055-00	720	99,420.00	0.00	96,951.93	0.00	2,468.07
01/01/52	WATER PIPES - 1	000055-01	720	3,820.00	0.00	3,661.75	0.00	158.25

City of Live Oak

FUND: 012 - WATER ENTERPRISE FISCAL YEAR: 07/2009-06/2010

DATE ACQUIRED	DESCRIPTION	ID	TOTAL LIFE	TOTAL COST	SALVAGE VALUE	PRIOR PERIOD ACCUM DEPR	CURRENT PERIOD 07/2009-06/2010	NET VALUE
01/01/63	WATER PIPES - 1	000055-02	840	51,096.00	0.00	33,957.45	0.00	17,138.55
01/01/75	WATER PIPES - 1	000055-03	840	9,392.00	0.00	4,630.90	0.00	4,761.10
01/01/78	WATER PIPES - 1	000055-04	840	293,722.00	0.00	132,222.97	0.00	161,499.03
01/01/79	WATER PIPES - 1	000055-05	840	35,326.00	0.00	15,397.73	0.00	19,928.27
01/01/80	WATER PIPES - 1	000055-06	840	39,317.00	0.00	16,575.66	0.00	22,741.34
01/01/83	WATER PIPES - 1	000055-07	840	199,019.00	0.00	75,368.47	0.00	123,650.53
01/01/84	WATER PIPES - 1	000055-08	840	29,229.00	0.00	10,651.48	0.00	18,577.52
01/01/85	WATER PIPES - 1	000055-09	840	110,711.00	0.00	41,559.65	0.00	77,151.35
01/01/88	WATER PIPES - 1	000055-10	600	20,487.00	0.00	8,812.04	0.00	11,674.96
01/01/91	WATER PIPES - 1	000055-11	600	105,453.00	0.00	39,025.30	0.00	66,427.62
01/01/92	WATER PIPES - 1	000055-12	600	107,970.00	0.00	37,797.65	0.00	70,172.35
01/01/93	WATER PIPES - 1	000055-13	600	257,103.00	0.00	84,850.50	0.00	172,252.50
01/01/94	WATER PIPES - 1	000055-14	600	509,844.00	0.00	158,064.53	0.00	351,779.47
01/01/97	WATER PIPES - 1	000055-15	600	152,646.00	0.00	38,157.68	0.00	114,480.32
01/01/93	WATER METERS -	000056-00	180	116,181.00	0.00	116,181.00	0.00	0.00
01/01/98	WATER METERS -	000056-01	180	135,781.00	0.00	104,092.17	0.00	31,608.83
01/01/02	WATER METERS -	000056-02	180	10,769.00	0.00	5,382.35	0.00	5,386.65
02/27/03	WATER MAIN REPL	000086-00	360	299,386.00	0.00	63,260.39	0.00	236,125.61
01/01/51	FIRE HYDRANTS -	000101-00	600	17,472.00	0.00	17,472.00	0.00	0.00
01/01/52	FIRE HYDRANTS -	000101-01	600	581.00	0.00	581.00	0.00	0.00
01/01/63	FIRE HYDRANTS -	000101-02	600	7,469.00	0.00	6,947.99	0.00	521.01
01/01/75	FIRE HYDRANTS -	000101-03	600	2,163.00	0.00	1,492.94	0.00	670.06
01/01/78	FIRE HYDRANTS -	000101-04	600	37,233.00	0.00	23,464.71	0.00	13,768.29
01/01/79	FIRE HYDRANTS -	000101-05	600	5,944.00	0.00	3,627.07	0.00	2,316.93
01/01/80	FIRE HYDRANTS -	000101-06	600	4,823.00	0.00	2,846.46	0.00	1,976.54
01/01/83	FIRE HYDRANTS -	000101-07	600	8,191.00	0.00	4,342.74	0.00	3,848.26
01/01/84	FIRE HYDRANTS -	000101-08	600	4,353.00	0.00	2,220.68	0.00	2,132.32
01/01/85	FIRE HYDRANTS -	000101-09	600	23,943.00	0.00	11,735.13	0.00	12,207.87
01/01/87	FIRE HYDRANTS -	000101-10	600	13,796.00	0.00	6,209.97	0.00	7,586.03
01/01/88	FIRE HYDRANTS -	000101-11	600	2,359.00	0.00	1,014.63	0.00	1,344.37
01/01/91	FIRE HYDRANTS -	000101-12	600	12,666.00	0.00	4,687.46	0.00	7,978.54
01/01/92	FIRE HYDRANTS -	000101-13	600	12,942.00	0.00	4,530.76	0.00	8,411.24
01/01/93	FIRE HYDRANTS -	000101-14	600	32,024.00	0.00	10,560.68	0.00	21,455.32
01/01/94	FIRE HYDRANTS -	000101-15	608	30,680.00	0.00	9,511.52	0.00	21,168.48
01/01/95	FIRE HYDRANTS -	000101-16	600	2,895.00	0.00	839.55	0.00	2,055.45
01/01/97	FIRE HYDRANTS -	000101-17	600	9,026.00	0.00	2,256.13	0.00	6,769.87
09/15/04	APRICOT VILLAGE	000107-06	600	3,300.00	0.00	316.29	0.00	2,983.71
04/20/05	HOME FIRST ESTA	000109-06	600	15,624.00	0.00	1,310.25	0.00	14,313.75
04/20/05	HOME FIRST ESTA	000109-07	600	101,637.00	0.00	8,522.95	0.00	93,114.05
05/04/05	PENNIHGTON RANC	000110-06	600	66,500.00	0.00	5,528.66	0.00	60,971.34
05/04/05	PENNINGTON RANC	000110-07	600	389,550.00	0.00	32,385.72	0.00	357,164.28
02/15/06	WALNUT VIEW SUB	000120-06	600	11,853.00	0.00	799.40	0.00	11,053.60
02/15/06	WALNUT VIEW SUB	000120-07	600	353,774.00	0.00	23,863.44	0.00	329,910.56
02/15/06	PEACHTREE II PH	000121-06	600	10,564.00	0.00	712.46	0.00	9,851.54
02/15/06	PEACHTREE II PH	000121-07	600	230,857.00	0.00	15,572.13	0.00	215,284.87
04/19/06	VALLEY OAK ESTA	000123-06	600	8,000.00	0.00	511.35	0.00	7,488.65
04/19/06	VALLEY OAK ESTA	000123-07	600	45,046.00	0.00	2,878.80	0.00	42,167.20
05/03/06	PEACHTREE III S	000124-06	600	21,000.00	0.00	1,327.10	0.00	19,672.90
05/03/06	PEACHTREE III S	000124-07	600	242,650.00	0.00	15,332.44	0.00	227,317.56
06/07/06	PENNINGTON RANC	000128-06	600	45,500.00	0.00	2,788.30	0.00	42,711.70

City of Live Oak

FUND: 012 - WATER ENTERPRISE FISCAL YEAR: 07/2009-06/2010

DATE ACQUIREU	DESCRIPTION	ID	TOTAL LIFE	TOTAL COST	SALVAGE VALUE	PRIOR PERIOD ACCUM DEPR	CURRENT PERIOD 07/2009-06/2010	NET VALUE
06/07/06	PENNINGTON RANC	000128-07	600	368,710.00	0.00	22,596.40	0.00	346,113.60
08/17/06	2006 CATERPILLA	000132-00	60	82,609.70	0.00	46,812.22	0.00	35,797.48
06/30/07	2006 CATERPILLA	000132-01	60	12,450.00	0.00	4,980.00	0.00	7,470.00
11/15/06	WATER STORAGE T	000134-00	360	2,305,590.01	0.00	204,941.44	0.00	2,100,648.57
02/21/07	Larkin Rd Impro	000138-04	600	326,465.00	0.00	15,235.08	0.00	311,229.92
10/20/06	Water Meter Imp	000141-00	120	1,478,134.97	0.00	394,169.28	0.00	1,083,965.69
07/18/07	PENNINGTON RANC	000142-06	600	61,600.00	0.00	2,361.41	0.00	59,238.59
07/18/07	PENNINGTON RANC	000142-07	600	412,282.00	0.00	15,804.22	0.00	396,477.78
07/01/08	Water Main Proj	000147-00	360	1,233,423.88	0.00	41,114.16	0.00	1,192,309.72
05/15/09	Arsenic Removal	000153-00	360	3,123,366.34	0.00	17,352.04	0.00	3,106,014.30
03/27/09	Water System Im	000154-00	360	67,224.49	0.00	560.19	0.00	66,664.30
	REPORT TOTALS			14,335,195.66	0.00	2,483,191.19	0.00	11,852,004.47

CLASS TOTALS BY FUND

ACTIVE ASSETS

FUND	CLASS	NUMBER	TOTAL COST	SALVAGE VALUE	DEPRECIATION	NET VALUE
012	100	5	32,707.14	0.00	0.00	32,707.14
012	400	3	105,059.70	0.00	61,792.22	43,267.48
012	500	45	714,276.13	0.00	620,119.88	94,156.25
012	600	58	13,483,152.69	0.00	1,801,279.09	11,681,873.60
GRAND TOTALS:		111	14,335,195.66	0.00	2,483,191.19	11,852,004.47

City of Live Oak

DEPARTMENT TOTALS

ACTIVE ASSETS

FUND	DEPARTMENT	NUMBER	TOTAL COST	SALVAGE VALUE	DEPRECIATION	NET VALUE
012	1200	111	14,335,195.66	0.00	2,483,191.19	11,852,004.47
GRAND TOTALS:		111	14,335,195.66	0.00	2,483,191.19	11,852,004.47

City of Live Oak

G/L ACCOUNT TOTALS

ACTIVE ASSETS

FUND	ACCOUNT	NUMBER	TOTAL COST	DEPRECIATION
012	1027	5	32,707.14	
012	1031	106	14,302,488.52	
012	1033	106		2,483,191.19
GRAND TOTALS:		111	14,335,195.66	2,483,191.19