City of Clovis

Water Master Plan Update Phase III

April 2017

Prepared for:

City of Clovis

Clovis, CA

Prepared by:

Provost & Pritchard Consulting Group

2505 Alluvial Ave, Clovis, CA 93611

Report Prepared for:

City of Clovis

155 N. Sunnyside Avenue

Clovis, CA 93612

Report Prepared by:

Provost & Pritchard Consulting Group

Brian Ehlers, PE

Heather Bashian, PE

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Abbreviations

AACE .... American Association of Cost Engineers
ac .... acre
ADD .... Average Day Demand
AF .... Acre-feet
AFY .... Acre-feet per year
Authority .... San Joaquin River Exchange Contractors Water Authority
AWWA .... American Water Works Association
BPS .... Booster Pump Station
cfs .... cubic feet per second
City .... City of Clovis
County .... County of Fresno
CVP .... Central Valley Project
DBCP 1,2,-Dibromo-3-chloropropane
DBO .... Design-Build-Operate
DMC .... Delta-Mendota Canal
DWR .... Department of Water Resources
EDB .... ethylene dibromide
EO .... Executive Order
EPA .... Environmental Protection Agency
ET .... Evapotranspiration Rate
FID .... Fresno Irrigation District
FMFCD .... Fresno Metropolitan Flood Control District
ft .... feet
GAC .... Granular Activated Carbon
GP .... General Plan
gpcd .... gallons per capita per day
gpm .... gallons per minute
GWD .... Garfield Water District
I-5 .... Interstate 5
in .... inches
IWD .... International Water District
KDSA .... Ken D. Schmidt & Associates

KRWA .... Kings River Water Association
M&I .... Municipal & Industrial
MCL .... Maximum Contaminant Level
MDD .... Maximum Day Demand
MG .... Million Gallons
MGD .... Million Gallons per Day
Mn .... Manganese
No. .... Number
PCE .... Tetrachloroethylene
PH .... Peak Hour
PHD .... Peak Hour Demand
PS .... Pump Station
ROW .... Right of Way
RT .... Research & Technology Park
SBx7-7 .... Senate Bill x7-7
SGMA .... Sustainable Groundwater Management Act
SJR .... San Joaquin River
SOI .... Sphere of Influence
SR .... State Route
ST/WRF .... Sewage Treatment/Water Reuse Facility
SWRCB .... State Water Resources Control Board
SWTP .... Surface Water Treatment Plan
TCE .... Trichloroethylene
TCP 1,2,3-Tricholoropropane
TDS .... Total Dissolved Solids
T-X .... Tarpey Well No. X
UAFW .... Unaccounted for Water
UDF .... Unit Demand Factor
USACE .... United States Army Corps of Engineers
UWMP .... Urban Water Management Plan
yr .... year

Executive Summary

This report has been prepared to support the adopted 2015 Clovis General Plan. The adopted plan has a number of phased boundaries that are recognized herein; specifically planning for growth within the existing sphere boundary and then ultimately buildout of the General Plan. The primary purpose for this report is to examine the feasibility of continued growth in the greater Clovis area from a water resource stand point and develop a plan for implementation of facilities as well as development of a plan for acquisition of water supplies as the City continues to grow in an easterly direction with more limited groundwater supplies. Water supplies considered include surface, groundwater and reclaimed water. Prior to 2004, municipal demands were met with pumped groundwater. Since that time, the City has continued to expand the use of treated surface water and it presently accounts for about 25 percent of the supply. As the City continues to grow, it is planned that the long term average of groundwater supplies will remain constant and the increase in demand will be met with increased surface water treatment as well as increased use of recycled water supplies.

Introduction

The City of Clovis has historically relied exclusively on groundwater for meeting the water supply needs of the community. Most cities and communities that are located along the floor of the San Joaquin Valley have similarly grown accustomed to this seemingly endless source of water. It is pristine, cool, and refreshingly palatable to the taste. We take for granted that this groundwater supply will be there, forever. Such is not the case. With the easterly development of the City towards the foothills, the aquifer of the valley is left behind. Other means of supply must be developed to sustain the growth of the community.

This report represents an update of the Phase 1 and 2 reports that were prepared in 1995 and 1999 respectively, that provided a blueprint for the future development of the city's water system. This report documents the past years' efforts in evaluating the existing system and developing the future plan for the system. It should be recognized that this is a long-term approach to planning for the water development and supply needs for the City into the 21st century. The planned land uses in the 2015 General Plan are the blueprint upon which this study is based. Evaluations were made as to the current water demands so that projections could be made for future years. It should also be recognized that recently California has experienced one of the most severe droughts in recent history. There are a number of regulatory actions calling for reduced water use as a reaction to the drought and it remains to be seen the impact these actions could have regarding the water uses and demands in the city for future years.

Phase I of the Plan Update, which was completed in April, 1995, investigated three alternatives to meet water supply needs at buildout of the General Plan area. They included: 1) total reliance on groundwater and groundwater recharge; 2) large scale use of surface water as the principal supply; and 3) a combination of groundwater, groundwater recharge and surface water (conjunctive use).

It was determined that a conjunctive use program was the most cost effective and implementable alternative to maximize the resources available to the City. This alternative was approved by the City Council in July 1995 and used as the basis for completion of the Phase II Facilities Plan. Many of the components included in the Phase II Plan have been implemented and the system has performed well. However, groundwater levels have continued to decline but at a lesser rate than previous indicating a need to continue to be vigilant on implementing intentional recharge efforts.

This continued strategy including reliance on groundwater and treated surface water to provide a secure, drought-resistant water supply should be continued. The recommended plan has been structured to be cost-effective and operationally efficient. In addition, it has been developed to be conducive to phased development, which is critical both to community approval and existing operational constraints. The phased development approach allows the City to provide the needed facilities just in time to serve the increasing demands of growth. The rate at which growth occurs will dictate the implementation schedule for construction of new water supply and delivery facilities.

Land Use Description

The study area encompasses approximately 47,500 acres, of which nearly 15,200 are within the current city limits. To facilitate planning efforts, three areas were identified to focus growth including Loma Vista, a 3,308-acre area east of Locan Avenue; Northwest, a 2,630-acre area north of Shepherd Avenue and east of Willow Avenue; and Northeast, a 9,032-acre area north of Shepherd Avenue and generally east of Armstrong and Thompson Avenues. For the purposes of this study, the general plan area was divided into nine subareas as listed below and shown on **Figure ES-1**.

- Clovis
- Northwest Village
- Northeast Triangle
- Loma Vista
- Northeast Village
- Northern Rural
- Northeast Corner
- Between Canals
- Southeast Corner

The total acreages within each subarea for the general plan area are shown in **Table ES-1** while the total acreages within each land use are shown in **Table ES-2**.

Table ES-1: Summary of Acreages by Subarea

Sub Area Name	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Clovis	13,510	61%	13,510	28%
Northwest Village	2,629	12%	2,629	6%
Northeast Triangle	1,648	7%	2,078	4%
Loma Vista	3,309	15%	3,309	7%
Northeast Village	1,037	5%	9,032	19%
Northern Rural	-	-	1,831	4%
Northeast Corner	-	-	3,000	6%
Between Canals	-	-	7,487	16%
Southeast Corner	-	-	4,642	10%
Total	**22,133**	**100%**	**47,518**	**100%**

Table ES-2: Summary of Acreages by Land Use Type

Land Use Type	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	68	<1%	5,482	12%
Rural Residential	958	4%	11,114	23%
Very Low Density	774	3%	775	2%
Low Density	5,459	25%	6,226	13%
Medium Density	3,265	15%	4,388	9%
Medium High Density	1,144	5%	1,746	4%
High Density	503	2%	731	2%
Very High Density	32	<1%	123	<1%
Mixed Use - Village	823	4%	1,021	2%
Mixed Use - Business	1,018	5%	1,018	2%
Office	287	1%	287	1%
Industrial	548	2%	548	1%
Neighborhood Commercial	42	<1%	42	<1%
Special Commercial	-	-	170	<1%
General Commercial	846	4%	876	2%
Open Space	259	1%	4,273	9%
Public Facilities	246	1%	257	1%
Park	451	2%	535	1%
School	739	3%	1,075	2%
Water	750	3%	1,149	2%
Right-of-Way	3,921	18%	5,415	11%
Planned Rural Community	-	-	267	1%
Total	**22,133**	**100%**	**47,518**	**100%**

Figure ES-1: Subareas within the General Plan Study Area

Population

The population of the City was 104,339 in 2015, nearly doubling in size since 2000. While the annual growth rate in those years averaged 2.9%, the Great Recession significantly lowered that rate to below two percent. For purposes of planning, within the service area population projections are based on the 2016 population estimate of 108,039, a growth rate of 2.9% for the City up to 2021, a 2.5% growth rate from 2022 to 2035, and 3,888 non-growth population for Tarpey Village. The historical and projected populations are shown in **Figure ES-2**.

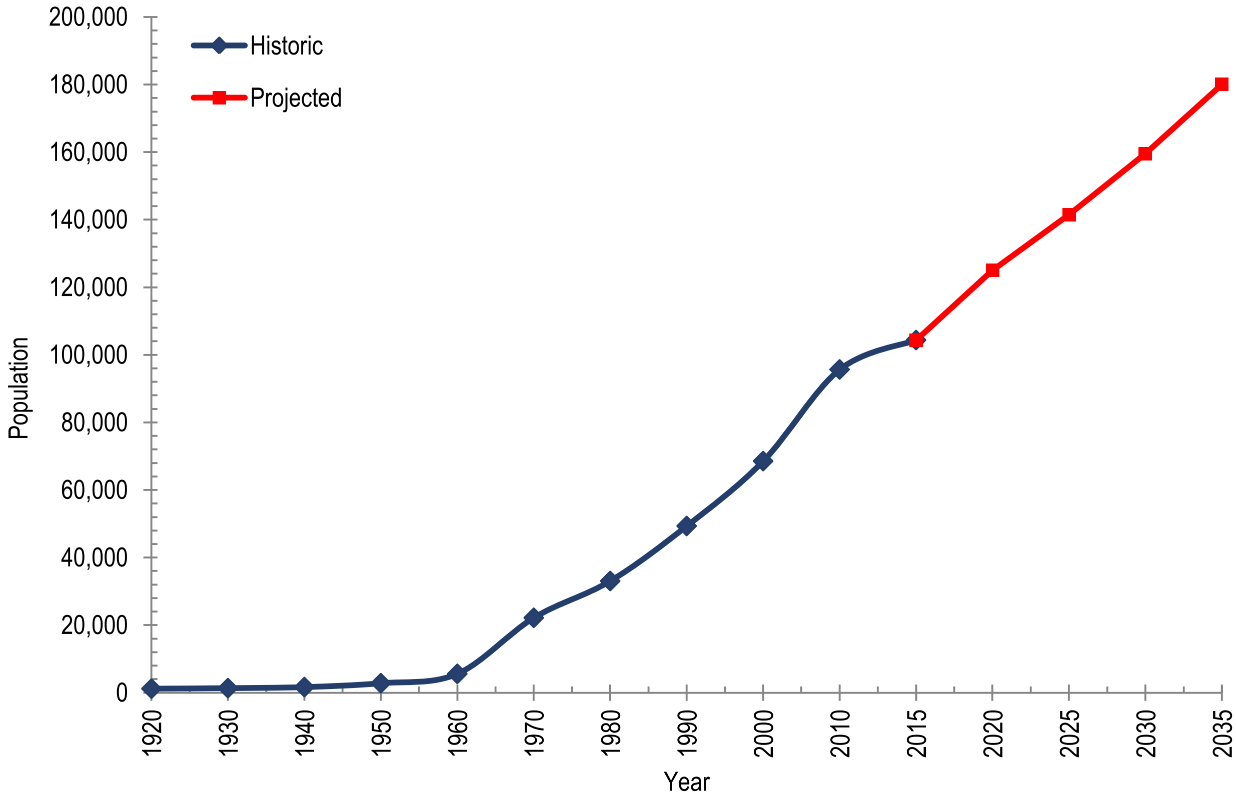


Figure ES-2: Historic and Projected Population

The population projection associated with the full buildout of the general plan (2083) is 280,300.

System Description

The City has historically relied primarily on groundwater supplies; however, with the startup of the surface water treatment plant (SWTP) in 2004, that reliance has begun to shift. **Figure ES-3** illustrates groundwater production and surface water production from 1984 to 2015. As can been seen from the figure, for the time period from 2005 to 2015 groundwater production has made up approximately seventy-two percent (72%) of total combined production. In the most recent completed year, 2015, the groundwater percentage was down to sixty-one (61%) of total production.

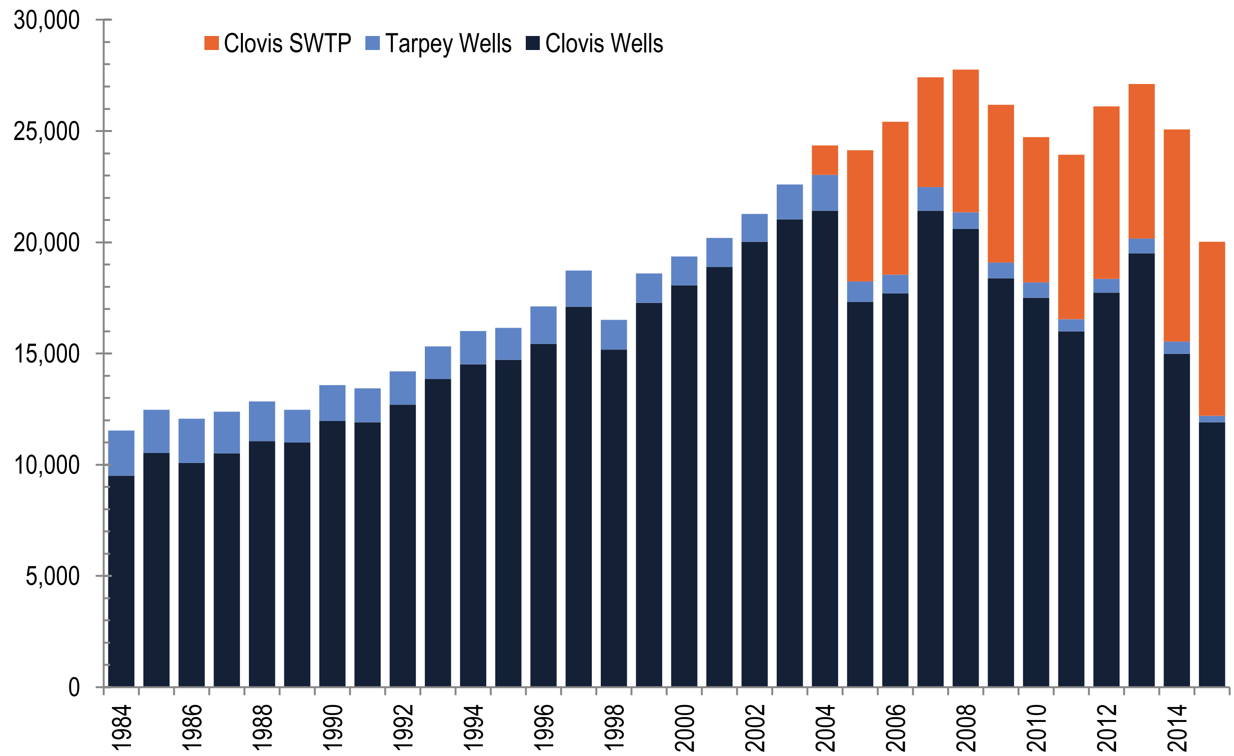


Figure ES-3: Historic Groundwater and Surface Water Production

The SWTP is currently operating with a capacity of 22.5 million gallons per day (MGD) with an ultimate capacity of 45 MGD. The City also owns a Sewage Treatment/Water Reuse Facility (ST/WRF), which began operating in 2009 and has a capacity of 2.8 MGD; its ultimate capacity will be 8.4 MGD. The recycled water supply complies with Title 22 standards with unrestricted uses such as irrigation, impounding, cooling, and commercial/industrial applications. Currently, primary recycled water use is in landscaped areas adjacent to the recycled water transmission main.

Pressure Zones

Discussions of the present system with operating staff and analyses of present operations have revealed several important facts. Although the system is operating satisfactorily at present, low pressures are sometimes experienced in the northern and eastern portions of the system. The land in Clovis and its environs rises toward the east and northeast. As the City has grown in this direction, so has the water system. Most of the water production is in the central and south westerly (lowest) part of the City. The net result is that to maintain adequate pressure in the east and northeast, pressures must be higher in the southwest.

The existing system has two pressure zones as shown on **Figure ES-4**. Although separate pressure zones will provide better overall pressure throughout the City, the existence of zone boundaries complicates the transfer of water between zones. The movement of water between the zones has not been a significant problem; however, recently pressure concerns have arisen and will necessitate the modification of operating valves between the pressure zones.

System operation concerns that have been identified consist of:

- Modifying surface water treatment operations to match changing daily and weekly demands
- Non use of storage in Reservoir 4
- System impacts from Community Hospital
- Meeting summer demands when FID treats for algae and the SWTP become inoperable

The recommended plan includes a secondary SWTP and interconnection with the primary SWTP and the Friant-Kern Canal so that the surface water supplies can be utilized year round and not be negatively impacted by both turbidity spikes in the Enterprise Canal nor the operational activities of the FID. Modification of the system configuration is planned to include expansion of the SWTP, additional storage tanks and pumping facilities to accommodate inter-zonal transfers of water.

Reduction of Demand for Treated Water

To reduce treated water requirements, expansion of the reclaimed water system is planned. Reference is made to the Recycled Water Master Plan for specifics but it is planned that the Northwest village will use significant reclaimed water especially in the open/green space areas. It is also recognized that in this Mediterranean climate that the most dominant use for this supply is for landscaped areas. In the winter months this demand is small and to efficiently use this supply it is recommended to be recharged. New recharge sites are encouraged in the Northwest village as well as modification of the permitting to allow for use in the Marion Recharge facility.

Figure ES-4: Major Existing Infrastructure

System Demands

Based upon the land use designations in the 2015 General Plan, projected water delivery requirements were determined for the sphere and the general plan buildout area. At buildout (projected year 2083 and a corresponding population of 280,300) the average demand for City water will be 65,400 acre-feet per year based on land use demand factors. This represents an average annual per capita use of 208 gallons per capita per day. Two design parameters that most affect the water distribution system are the maximum daily demand and the peak hour demand. At the planning horizon, these two values are 72,000 and 121,500 gallons per minute, respectively; at present, these demands are 28,500 and 50,400 gallons per minute, respectively. Projected growth will more than double the peak need for water deliveries. It is planned that new supplies will be brought on line in accordance with increased demands. The total demands within each subarea are shown in **Table ES-3**.

Table ES-3: Summary of Demands by Subarea

Sub Area Name	SOI Boundary		General Plan Boundary	
	Demand (AFY)	Percentage of Total	Demand (AFY)	Percentage of Total
Clovis	25,200	56%	26,700	41%
Northwest Village	6,500	14%	7,000	11%
Northeast Triangle	3,700	8%	4,700	7%
Loma Vista	5,600	12%	7,700	12%
Northeast Village	4,000	9%	19,300	30%
Northern Rural	-	-	-	-
Northeast Corner	-	-	-	-
Between Canals	-	-	-	-
Southeast Corner	-	-	-	-
Total	**45,000**	**100%**	**65,400**	**100%**

Seasonal fluctuations in demand will allow the City to optimize surface water delivery so that groundwater resources can be available during extended droughts. To do so, the surface water treatment plant (SWTP) will be base-loaded as shown in **Figure ES-5** to maximize its water production capabilities. As the City continues to grow, and the surface water becomes the dominant source of supply, it will be important to maintain the reliability of the plant and plan for its operation year round. It will be important for the City to have another connection of supply which could be the Friant-Kern Canal and a second SWTP in the Northeast Village. Year-round use of treated surface water will allow the City to "bank" groundwater for later use during summer months or protracted drought periods.

System Supplies

It is envisioned that treated surface water will eventually provide approximately 70 percent of total annual supplies. Groundwater will satisfy 25 percent, and recycled water for outside landscape purposes will satisfy the remainder. At this time, it is intended that only the planned urban lands are to be served water from the system. Said more directly it is not planned to serve the rural residential lands. However, it is probable that some rural residential properties in close proximity to the system will request service. It may be cost-effective for the City system to serve in-the-house water demands in nearby rural residential lands. Should this be desirable in the future, water demands would be higher and raw water supplies must be adjusted upward. The system supplies are shown historically and projected to 2015 in **Figure ES-5**. The total supplies within each subarea are shown in **Table ES-4**.

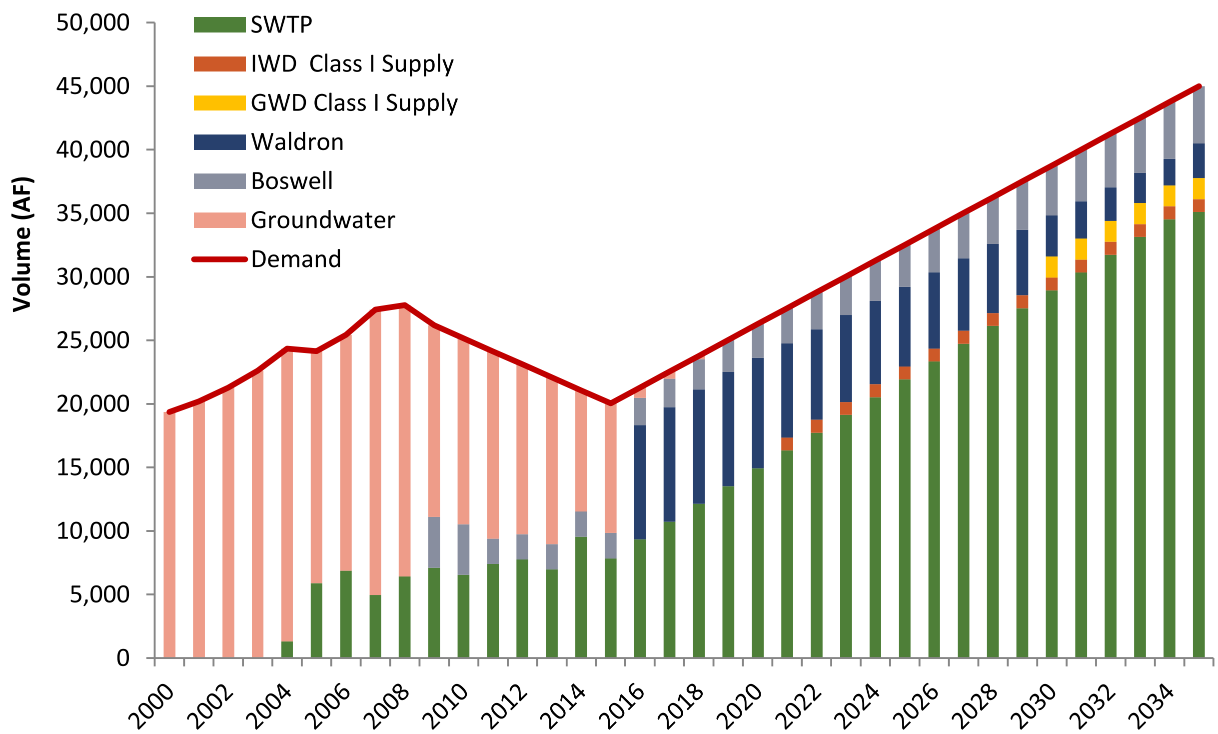


Figure ES-5: Evaluation of Supplies at Buildout of Urban Villages

Table ES-4: Summary of Supplies by Subarea

Sub Area Name	SOI Boundary		General Plan Boundary	
	Supply (AFY)	Percentage of Total	Supply (AFY)	Percentage of Total
Clovis	39,200	66%	39,200	55%
Northwest Village	5,250	9%	5,250	7%
Northeast Triangle	4,950	8%	4,950	7%
Loma Vista	9,050	15%	9,050	13%
Northeast Village	1,050	2%	1,350	2%
Northern Rural	-	-	100	<1%
Northeast Corner	-	-	-	-
Between Canals	-	-	1,200	2%
Southeast Corner	-	-	10,100	14%
Total	**59,500**	**100%**	**71,200**	**100%**

Note: Surface water supplies for unserved areas are not available for City use; FID, GWD and IWD supplies are shown for reference but for the Northern Rural, Northeast Corner, Between Canals, and Southeast Corner villages but are not used in the later reconciliation.

Groundwater

A number of factors influence the potential to develop groundwater for public supply in the study area. These factors include subsurface geologic conditions, depth to water and water-level trends, aquifer characteristics, recharge, and groundwater quality. Subsurface geologic conditions below the water level are important in terms of well yields and conditions above the water level are important when considering potential recharge operations.

The findings of the report with respect to groundwater may be summarized as follows:

- The aquifer is thickest under the southwest portion of the City, generally south of Herndon and West of Clovis Ave.
- To the north and east of Clovis, the aquifer thins substantially and bedrock becomes shallow with a resulting reduction in water production capacity.
- Planned growth areas are less favorable for groundwater development than in the existing City of Clovis.
- Existing groundwater pumping levels exceed recharge rates, resulting in continued lowering of groundwater levels in most parts of the area.
- For the past 10 years pumping amounts within the city have stabilized at about 20,000 af/year, while intentional recharge has declined and averaged 5,000 Acre-Feet/Year.
- Surface and subsurface geologic conditions favorable for intentional recharge are limited.
- The areas most favorable for intentional recharge activities are along Dry Creek and other stream channels.

- Groundwater quality impairment has lessened and does not require as many well head treatment systems as in the past.
- TCE contamination is a new constituent and may require treatment systems that had not previously been in place.

Surface Water

Within the study area there are lands included in the Fresno Irrigation District, "annexed" lands to the FID, Garfield Water District and International Water District. These agencies have surface water entitlements from either or both of the San Joaquin River and the Kings River. The Kings River supply is the predominant surface water source accounting for over ninety percent of total available supplies to the study area. Kings River water is not allowed to be taken outside of the Kings River Water Association boundaries (which roughly correspond to the Enterprise Canal) which may cause problems with supply of water to lands in the northeast portion of the study area.

Surface water deliveries to the study area have approximated the surface water supplies available for the past ten years. During this same time, groundwater overdraft has occurred, suggesting that increased utilization of surface water supplies will be imperative as development occurs to avoid worsening the overdraft condition. Also, it will be important for the City to utilize the use of banked water supplies with Fresno Irrigation District during drought events.

The findings with regard to surface water may be summarized as follows:

- There is potentially an adequate supply of surface water to meet the growth proposed in the General Plan if proper measures are taken to develop the supply and insure its full utilization.
- The capability to intentionally recharge large quantities of water in the study area is limited. For full utilization of surface supplies, direct delivery will be required.
- Surface water may be utilized for irrigation and intentional recharge without treatment. Surface water used for human consumption must undergo treatment.

System Supply and Demand Reconciliation

The City has several supply sources available for its use, as discussed above, including groundwater, surface water and recycled water. The existing system has sufficient supplies to meet the demands as does the buildout of the current sphere of influence boundary (2035); however, there is a deficit at the full buildout of the general plan area of approximately 5,600 AFY. Additionally, individual villages have supply shortages at both the 2035 and 2083 planning stages that will require operational modifications. **Table ES-5** illustrates the supply and demand reconciliation, by village for a normal water year.

During a critical dry year, the SOI and General Plan areas have deficits of 8,800 and 29,100 AFY, respectively. Whereas in a multi dry year scenario, the deficit is as great as 30,000 without any additional conservation; however, there are years with surplus, also.

Table ES-5: Projected Water Supply

Subarea Name	SOI Boundary (2035)			General Plan Boundary (2083)		
	Total Demand (AFY)	Total Supply (AFY)	Difference (AFY)	Total Demand (AFY)	Total Supply (AFY)	Difference (AFY)
Clovis	25,200	39,200	14,000	26,700	39,200	12,500
Northwest Village	6,500	5,250	(1,250)	7,000	5,250	(1,750)
Northeast Triangle	3,700	4,950	1,250	4,700	4,950	250
Loma Vista	5,600	9,050	3,450	7,700	9,050	1,350
Northeast Village	4,000	1,050	(2,950)	19,300	1,350	(17,950)
Northern Rural	-	-	-	-	-	-
Northeast Corner	-	-	-	-	-	-
Between Canals	-	-	-	-	-	-
Southeast Corner	-	-	-	-	-	-
Total	**45,000**	**59,500**	**14,500**	**65,400**	**59,800**	**(5,600)**

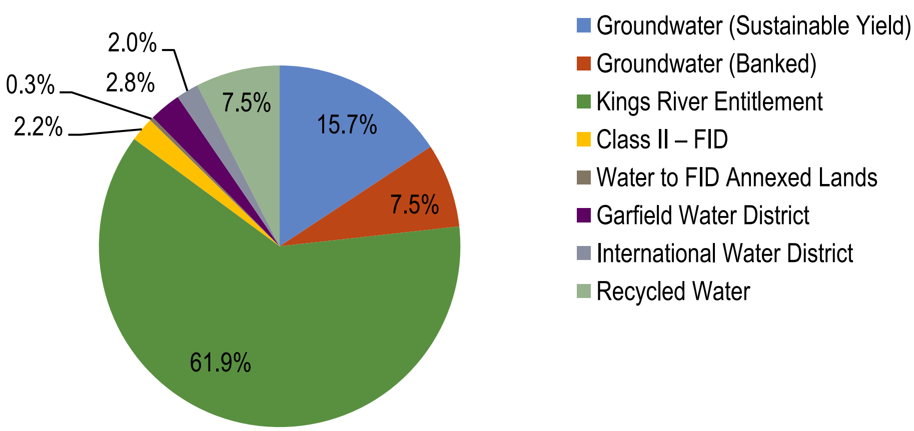


Figure ES-6: General Plan Buildout Water Supplies

Recommended Facilities

As the City grows, additional facilities will be necessary to meet the growing water demands. **Figure ES-6** is a map showing the planned facilities to meet build-out conditions of the General Plan. Major features consist of an expansion of the existing SWTP to an ultimate 45 MGD capacity and a secondary 20 MGD SWTP located near the confluence of the Big Dry Creek and the Friant-Kern Canal including an interconnecting 42-inch raw water pipeline between the two SWTPs. Other features include 80 acres of additional recharge basins, the addition of 7 new wells, 5 pumping stations and 77 miles of conveyance and distribution piping varying in size from 12 to 42 inches; 24 million gallons of new storage is also planned.

Costs

As documented later in this report, project costs for the proposed water supply facilities are estimated at approximately $220 million. **Table ES-6** shows the anticipated facilities needed by Subarea and **Table ES-7** shows them by Phase. Additionally, approximately $2 million should be programmed each year for the cost of surface water procurement.

Table ES-6: Summary of Capital Improvement Costs by Subarea

Subarea Name	Length of Mains	Cost
Clovis	64,280	$71.9M
Northwest Village	84,025	$55.9M
Northeast Triangle	16,725	$2.5M
Loma Vista	61,450	$9.6M
Northeast Village	180,225	$80.2M
Totals:	**406,705**	**$220.1M**

Table ES-7: Summary of Capital Improvement Costs by Phase

Phase	Length of Main	Cost
Phase 1 (2016-2020)	100,360	$54.1M
Phase 2 (2020-2030)	109,095	$93.9M
Phase 3 (2030-2040)	40,860	$42.8M
Phase 4 (2040-2050)	156,390	$29.3M
Totals:	**406,705**	**$220.1M**

Recommended Actions

The following list the recommendations that have resulted from this investigation:

- The City should initiation discussions with FID regarding modifications to the water supply service area.
- The City should develop working relationships with nearby agencies with water resources and responsibilities in the area.
- Execute the water banking clause regarding annexation of lands and acquisition of associated water supplies.
- Develop a cost allocation method for payment of operating costs and importing water from GWD and IWD.
- Develop a cost allocation method for purchasing new imported water during multiple dry year periods.
- Discuss and resolve limitations within the FID/Clovis Cooperative Supply and Delivery Agreements.
- Increase the amount of water directed to existing recharge basins and increase amount of recharge facilities.
- Consider negotiation of an agreement with FID and/or the City of Fresno to provide provisions for making exchange water available to the City from the Regional Wastewater Treatment Facility.
- Develop a policy for delivery of potable water to rural residential parcels.

1 Introduction

1.1 Project Purpose

The purpose of the City of Clovis (City) Water Master Plan Update – Phase III (Master Plan) is to determine future water infrastructure needs and potable demands for the preferred land use alternative in the adopted General Plan, identify facilities and sources of water supply to satisfy those needs, and provide budget level costs for infrastructure and supplies. To achieve aforementioned objectives, the planning area identified in the General Plan was segmented into nine (9) subareas with anticipated growth occurring in five (5) of those areas. **Figure 1.3-1** identifies the limits of the General Plan.

1.2 Objectives

The goals and objectives of this Master Plan are as follows:

- Provide a report identifying water infrastructure needed to accommodate anticipated growth;
- Identify potential new water sources;
- Identify and summarize existing and future water demands;
- Identify constraints associated with both existing and potential water supplies;
- Develop a list of water supply related issues to help guide and prepare Clovis staff for discussions regarding the acquisition and uses of new water supplies.
- Provide a hydraulic model of the existing and future water distribution system; and
- Identify water infrastructure and budget level capital costs.

1.3 Previous Studies

Over the past twenty years, Clovis has completed and participated in numerous investigations related to development and management of water resources. Below is a list of significant water resources related reports and agreements completed during this period for Clovis and the planned growth areas.

- 2015 Urban Water Management Plan Update
- 2012 Kings Basin Integrated Regional Water Management Plan Update
- 2011 Boswell Water Banking and Reliability Agreement
- 2011 General Plan Update – Loma Vista Water Demand Evaluation
- 2010 Urban Water Management Plan Update
- 2007 Upper Kings Basin Integrated Regional Water Management Plan

Figure 1.3-1: Study Area

- 2005 Fresno Area Regional Groundwater Management Plan
- 2005 Urban Water Management Plan Update
- 2004 Waldron Pond Water Supply Reliability Agreement
- 2003 AB 303 Groundwater Monitoring and Recharge Investigation
- 2000 Urban Water Management Plan
- 1999 Water Master Plan Update – Phase II Facilities Plan
- 1997 Groundwater Management Plan
- 1997 Groundwater Recharge Investigation
- 1995 Water Master Plan Update-Phase I

1.4 Report Organization

The report is organized into fourteen (12) Chapters, the title and purpose of each chapter is listed below:

Table 1.4-1: Organization of Master Plan

Chapter	Subject	Description
1	Introduction	Identifies the purpose, objectives, and overall structure of the Master Plan
2	Associated Agencies	Describes the various agencies within the planning area that have a responsibility for, oversee, and influence water management decisions within the planning area
3	Land Use	Describes the various land uses planned for each village, and how land use acreage changed since the last master plan; the Chapter also includes a discussion on population
4	Existing Water System	Describes the service area, water supply sources, and facilities needed to supply and deliver potable water to users
5	Water Demands	Explains historic and project water use including land use based water demand factors and peaking factors
6	Groundwater Supply	Describes typical subsurface soils conditions, spatial distribution of water quality, and water level and groundwater pumping trends
7	Surface Water Supply	Provides an explanation about the types of surface water, describes hydrologic fluctuation of these types of water, and where water can be used

Chapter	Subject	Description
8	Recycled Water Supply	Details the planned recycled water facilities and supplies to be utilized by the City
9	Water Supply Reliability	Provides an explanation of the reliability of the City's groundwater, surface water and recycled water supplies including an analysis of normal and dry years
10	Water Supply Plan	Summarizes how demands within the villages and the City as a whole could be met with various water sources and identifies future water supply components
11	Water System Hydraulic Model	Identifies how a computer hydraulic model was used to evaluate existing and future water distribution system configurations
12	Capital Improvement Program	Explains budget/planning level capital costs for water infrastructure needed to provide potable water for buildout of the General Plan area

1.5 Assumptions and Limitations

Below is a list of assumptions and limitations that were used during the development of this report:

- Land use, as shown in the 2014 General Plan, is the basis of all area and water demand computations;
- Unit water demand factors developed for each land use type in the General Plan are based on water usage records from the City;
- Planning area was disaggregated into nine villages to facilitate reconciliation of supplies and demands;
- Future changes in per capita demand and general plan amendments may affect infrastructure sizes and utilization of water sources;
- Surface water cannot be exported into areas outside the place of use boundary for that particular water type; and
- Surface water supply for the Kings River is based on a range of anticipated entitlements and average hydrologic conditions.

2 Associated Agencies

Numerous agencies in the local area have responsibility for, oversee, and influence water supply and water management decisions by Clovis. Water supply resources available from these agencies consist mainly of surface water supplies from the Kings and San Joaquin Rivers, delivered to the City through the Fresno Irrigation District (FID) canal system; banked groundwater is provided by FID. Fresno Metropolitan Flood Control District (FMFCD) is responsible for the storm water management and does not directly control surface supplies. Management of storm waters by FMFCD improves the water balance condition for the City by capturing storm water and recharging the groundwater through flood control facilities scattered across FMFCD's district boundaries including nearly thirty basins in Clovis.

The following is a brief description of the local agencies that have water supply resources and/or water management policies that can impact the City's decision-making process. Each section provides a brief synopsis of the history, water supply, facilities, and purpose of each agency. A detailed explanation of water supplies available from these agencies is located in Chapter 3.

2.1 Fresno Irrigation District

Fresno Irrigation District (FID) is a public irrigation district that was formed under the California Irrigation District Law in 1920 and is the successor to the privately owned Fresno Canal and Land Company. The purpose of FID is to manage and protect the water supplies (surface and groundwater) of the district so they are available to meet current and future needs of the users.

FID is located within Fresno County and covers approximately 245,000 ac, which includes the majority of the Clovis and Fresno metropolitan areas. A map of FID's boundaries is shown on **Figure 2.1-1**. FID supplies water to agricultural and urban customers using Kings River and San Joaquin River waters conveyed by over 800 miles of canals and pipelines.

In approximately 1969, FID provided for the subordinate annexation of the Dog Mountain, Table Mountain and other properties to the District. Generally these properties are east of the original district boundary and along the Friant-Kern Canal. Though water supplies have not yet been discussed, it should be recognized that these annexed lands do not have entitlement to FID's water supplies.

In a normal year, FID delivers approximately 500,000 acre-feet (AF) of water; most goes to agricultural users, although an increasing share of FID's water supply is used for groundwater recharge in the Fresno-Clovis urban area. FID, along with the Cities of Fresno and Clovis, the County of Fresno, and the FMFCD, are involved in a cooperative effort to develop a comprehensive surface and groundwater management program. It was through this collective effort that the Regional Groundwater Management Plan was completed in 2005.

The City of Clovis has proactively been working with FID on water supply development and in 2004 entered into an agreement to finance and construct the Waldron Banking facility. More discussion on the specifics of this facility and resultant water supply will be discussed in Chapter 7.

Figure 2.1-1: Fresno Irrigation District

2.2 International Water District

International Water District (IWD) was formed in 1963 and delivers both surface water and groundwater for agricultural uses on approximately 550 acres (ac). IWD is located in the northeastern corner of the General Plan study area boundary and entirely within the Northeast Village. The boundary for this district is formed by Shepherd Avenue to the north, Thompson Avenue to the west, Del Rey to the east, and stair steps from Del Rey Avenue along the Pup Creek alignment to Thompson Avenue.

The only surface water supply available to IWD is provided under contract from the USBR for Central Valley Project (CVP) supplies from the San Joaquin River. In January 2001, IWD renewed their Long-Term Renewal Contract with the USBR for Project Water Service from the Friant Division of the CVP. This contract provides IWD with 1,200 AF of Class I water for municipal and industrial (M&I) purposes.

2.3 Garfield Water District

Garfield Water District (GWD) was formed in 1961 and is located at the northernmost point of the Northwest Village. GWD has a total area of 1,750 ac, of which 875 ac are within the NW village; the District delivers water to approximately 1,300 ac. In January 2001, GWD renewed their Long-Term Renewal Contract with the USBR for Project Water Service from the Friant Division of the CVP. The contract stipulates that the Contracting Officer shall make available for delivery to GWD 3,500 AF of Class I Water for irrigation purposes. Water is delivered to GWD via a turnout on the Friant-Kern Canal. The boundaries of the IWD and GWD are shown on

Figure 2.4-1.

2.4 County of Fresno Eastside Stream Group

The County of Fresno Eastside Stream Group (Group) is a consortium of local agencies that have filed a joint application with the State Water Resources Control Board (SWRCB) to acquire the rights to flood flows from major streams located upstream of Clovis. The Group includes the following members: Cities of Clovis and Fresno, FMFCD, and FID. The major water sources that make up the Fresno County Stream Group are: Big Dry, Pup, Dog, Fancher, Redbanks, and Mud Creeks. If a permit is granted by the SWRCB the waters from the Fresno County Stream Group would be used for direct diversion and recharge in FMFCD flood control facilities, which consist of Big Dry Creek reservoir, Pup Creek, and local basins throughout Clovis.

Figure 2.4-1: Garfield and International Water Districts

2.5 Kings River Water Association

The Kings River Water Association (KRWA) is a private entity that was formed in 1927 and consists of 28-member agencies (also referred to as "units"). These units consist of thirteen public districts and fifteen mutual water companies. KRWA is responsible for Kings River entitlements and deliveries of Kings River surface water for beneficial use on irrigated agricultural farmlands. FID is one of the units within KRWA, having the most direct relation to Clovis.

The service area boundary for KRWA extends from the San Joaquin River and Enterprise Canal south to the Tulare Lake Bed. The western boundary generally heads north from Kettleman City up to the South Fork of the Kings River and then continues northeast just passed the San Joaquin River, and terminates near Laton and Cole Slough (see **Figure 2-7.1**). This service area covers nearly one million acres of farmland and includes most of the Clovis and Fresno metropolitan areas.

2.6 Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District (FMFCD) is a local governmental agency formed to limit flood damage in the metropolitan areas of Fresno and Clovis. The FMFCD service area, including watersheds of urban areas and rural foothills, totals nearly 256,000 acres.

Within the study area identified in **Figure 1.3-1**, FMFCD has a total of 25 basins. Most of these basins are located west of the Enterprise Canal (see **Figure 2.7-2**). FMFCD uses the storm water basins in a variety of ways that benefit both the aquifer (dedicated recharge basin) and the community (combination recharge basin and park). Water is delivered to these facilities through FID and FMFCD infrastructure.

2.7 Exchange Contractors

The San Joaquin River Exchange Contractors hold historic water rights on the San Joaquin River (SJR) dating back to the late 1800s when they were established by Henry Miller (of Miller and Lux) beginning in 1871. In 1933, the United States Department of the Interior initiated the Central Valley Project (CVP) and, as part of the feasibility studies associated with the Project, negotiated with the heirs of Miller and Lux to exchange their water supply from the San Joaquin River for a water supply being developed by the Bureau of Reclamation at Shasta as part of the CVP. The exchange contractors per the exchange contract would receive guaranteed deliveries of substitute water from the Sacramento River via the planned Tracy Pumping Plant and Delta-Mendota Canal (DMC) rather than the more highly variable supplies from the SJR. This allowed for water to be diverted from the San Joaquin River to the east side of the valley through the planned Madera and Friant-Kern Canals.

This agreement, known as the Exchange Contract, was executed in 1939 and lead to the moniker San Joaquin River Exchange Contractors. In normal years, the Exchange Contractors are guaranteed 100% of their contractual water allotment (840,000 AF) and in critical years the amount is reduced to approximately 77% (650,000 AF).

The San Joaquin River Exchange Contractors Water Authority (Authority) services approximately 240,000 acres of land east of Interstate 5 (I-5) and primarily west of the San Joaquin River. These lands span the counties of Fresno, Madera, Merced, and Stanislaus, from the town of Patterson in the north to Mendota in the south. The Authority is comprised of four member agencies, Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company,

Figure 2.7-1: Kings River Water Association Service Area Boundary

Figure 2.7-2: Fresno Metropolitan Flood Control District Service Area Boundary

3 Land Use

The purpose of this chapter is to 1) describe land uses planned for the Sphere of Influence and General Plan areas, 2) discuss the conversion of agricultural land to urban uses, and 4) explain how population has and is projected to change over the next planning horizon.

3.1 Introduction

The General Plan highlights Clovis' intention to maintain its small town atmosphere as development occurs, which has been a consistent theme since the early 1990s. An excerpt from the land use element states:

> The land use element maintains Clovis' tradition of responsible planning and well-managed growth to preserve the quality of life in existing neighborhoods and ensure the development of new neighborhoods with an equally high quality of life. The goals and policies seek to foster more compact development patterns that can reduce the number, length, and duration of auto trips. The element also balances residential growth with economic and employment growth.

The General Plan Area encompasses approximately 47,520 acres (see **Figure 3.1-1** for a map of proposed land uses), of which nearly 15,200 acres are within the current Clovis city limits. To help facilitate planning efforts within the vast unincorporated areas of Fresno County (County) beyond the city limit, the General Plan identified three regional areas to focus growth consistent with the goals and policies of the General Plan. These Urban Centers include: Loma Vista, a 3,308-acre area east of Locan Avenue; Northwest, a 2,630-acre area north of Shepherd Avenue and east of Willow Avenue; and Northeast, a 9,032-acre area north of Shepherd Avenue and generally east of Armstrong and Thompson Avenues. Irrigated agriculture and rural residences, on 2 to 5 acre parcels, extend outward from the city limit into unincorporated areas of the County. Interspersed within this area are organized water districts – Garfield and International – that provide surface water to lands within their respective boundaries. Approximately forty percent (40%) of the study area is currently identified for urban or rural residential uses[1]; about ten percent (10%) is identified for commercial, office or industrial uses, including mixed use categories; the remainder is planned for a variety of public uses[2] or agriculture.

[1] Urban residential uses include Very-Low, Low, Medium, Medium-High, and High Densities.

[2] Public uses include Open Space, Park, Public Facilities, Right-of-Way, School, Water, and Undesignated areas.

Figure 3.1-1: Existing Land Use Map

Figure 3.1-2: Proposed Land Use Map

3.2 Subareas

The General Plan covers approximately 75 square miles within the central portion of the County of Fresno (County); to focus water related master planning efforts this area was segregated into regions smaller than the Urban Center configurations used in the General Plan. While portions of a subarea boundary may be coterminous with Urban Center boundaries other portions of subarea boundaries are coincident with major facilities such as canals or roadways. The study area was segregated into nine subareas, which are generally consistent with subareas used in the prior water master plan effort. Subareas included in this planning effort are as follows:

- Clovis
- Northwest Village
- Northeast Triangle
- Loma Vista
- Northeast Village
- Northern Rural
- Northeast Corner
- Between Canals
- Southeast Corner

See **Figure 3.2-1** for a map of the nine (9) subareas within the General Plan study areas.

Figure 3.2-1: Subareas within the Study Area

Clovis

The Clovis subarea is located in the southwest quarter of the General Plan area boundary, encompassing approximately 13,510 acres. The Clovis area is generally bounded by Willow Avenue on the west, Nees Avenue, Enterprise Canal and SR 168 on the north, DeWolf and Locan Avenues on the east and Gould Canal and Ashlan and Dakota Avenues on the south.

Within the Clovis subarea area there are over fifteen land use designations with most of the land already developed. Residential uses make up more than 50% of acreage with the remainder distributed between commercial, industrial, mixed use, schools, and other uses. Most of the undeveloped land is associated with the Research & Technology (RT) Park, Clovis Community Hospital, and the Herndon Avenue commercial corridor from Clovis Avenue to Tollhouse Avenue. Undeveloped residential lands represent a small portion of the total area and are sparsely distributed across the City.

Since the Clovis subarea is largely built-out modifications to remaining land use designations are limited. However, changing conditions in the development market or planning criteria are the only reasons to expect modifications to commercial, industrial, medium-high density residential, and office designations. In reviewing prior planning reports for this subarea, it was discovered that lands originally classified as mixed use are now distributed to three new land use categories (mixed use-village, mixed use-business, and neighborhood commercial) in addition to the general commercial and industrial uses. See **Table 3.2-1** for summary of land uses for each boundary condition.

Table 3.2-1: Clovis Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Rural Residential	958	7%	958	7%
Very-Low Density Residential	53	<1%	53	<1%
Low Density Residential	3,528	26%	3,528	27%
Medium Density Residential	1,795	13%	1,795	14%
Medium-High Density Residential	607	4%	607	5%
High Density Residential	230	2%	230	2%
Mixed Use – Village	178	1%	178	1%
Mixed Use – Business Campus	276	2%	276	2%
Office	287	2%	287	2%
Industrial	548	4%	548	4%
Neighborhood Commercial	19	<1%	19	<1%
General Commercial	822	6%	822	6%
Open Space	53	<1%	53	<1%
Public Facilities	161	1%	161	1%
Park	160	1%	160	1%
School	518	4%	518	4%
Water	425	3%	425	3%
Right-of-way	2,892	21%	2,892	22%
Total	**13,510**	**100%**	**13,188**	**100%**

Northwest Village

The Northwest Village is located in the northwest corner of the project area, adjacent to the northern City limits and covering unincorporated lands within the County, encompassing approximately 2,630 acres. The Northwest Village is formed by Copper Avenue on the north, Willow Avenue on the west, Shepherd Avenue on the south and Sunnyside Avenue on the east.

Previous land use designations consisted mostly of low density residential uses with recent planning efforts integrating more diverse land uses into this region. The planned uses include introduction of high density residential, mixed use, neighborhood commercial, office, public facilities and right-of-way designations as well as significant changes in acreage for low, medium, and medium-high density residential, park space, and water designations. See

Table 3.2-2 for a summary of land uses.

Table 3.2-2: Northwest Village Land Use

Land Use	SOI Boundary Land Uses		General Plan Boundary Land Uses	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Very-Low Density Residential	104	4%	104	4%
Low Density Residential	241	9%	241	9%
Medium Density Residential	954	36%	954	36%
Medium-High Density Residential	290	11%	290	11%
High Density Residential	78	3%	78	3%
Mixed Use – Village	418	16%	418	16%
Mixed Use – Business Campus	63	2%	63	2%
Neighborhood Commercial	14	1%	14	1%
Public Facilities	9	0%	9	0%
Park	80	3%	80	3%
Water	160	6%	160	6%
Right-of-way	218	8%	218	8%
Total	**2,629**	**100%**	**2,629**	**100%**

Northeast Triangle

Northeast Triangle is a subarea located between the Clovis, Northern Rural and Northeast Villages, encompassing an area of approximately 2,081acres. This subarea is generally bounded by State Route (SR) 168 on the south and east, Shepherd and Perrin Avenues and the Big Dry Creek Reservoir on the north, and Armstrong and Fowler Avenues and the Enterprise Canal on the west.

The area consists primarily of a variety of residential uses, mainly low and very-low density. **Table 3.2-3** identifies the distribution of current and future land uses of this subarea. The planned land uses focuses on shifting acreage between existing categories, mainly in low, medium, and medium-high density residential, open space, park, right-of-way and school designations. The previous mixed use acreage was distributed nearly identically in two new mixed use categories, business campus and village.

Table 3.2-3: Northeast Triangle Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Rural Residential	-	-	2	<1%
Very-Low Density Residential	530	32%	530	26%
Low Density Residential	276	17%	445	21%
Medium Density Residential	51	3%	151	7%
Medium-High Density Residential	86	5%	110	5%
High Density Residential	24	1%	24	1%
Mixed Use – Village	30	2%	44	2%
Mixed Use – Business Campus	143	9%	143	7%
Open Space	10	1%	49	2%
Public Facilities	4	<1%	4	<1%
Park	13	1%	35	2%
School	16	1%	32	2%
Water	78	5%	78	4%
Right-of-way	387	23%	431	21%
Total	**1,648**	**100%**	**2,078**	**100%**

Loma Vista

The Loma Vista subarea[3] covers approximately 3,308 acres within the southern portion of the General Plan Area and is adjacent to the eastern edge of the Clovis subarea. Loma Vista is bounded by Locan Avenue on the west, Bullard and Shaw Avenues on the north, Highland and McCall Avenues on the east and the Gould Canal and Ashlan and Dakota Avenues on the south.

For the past fifteen years, development within this subarea proceeded east from the Clovis subarea, to the City limits along DeWolf and Leonard Avenues. During this time, Loma Vista became the "home" to major facilities such as a surface water treatment plant, located along the south bank of the Enterprise Canal and Leonard Avenue, a sewage treatment water reuse facility, located along Ashlan Avenue and west of McCall Avenue, and the Reagan Educational Center at the northwest corner of Ashlan and Leonard Avenues.

The proposed land use concept plan for this subarea envisions a central core of public space, a park and mixed uses. Planned residential land use is prevalent in this subarea, accounting for approximately 60 percent of the acreage with densities ranging from very-low to very-high; other uses include mixed use, open space

[3] Prior to 2007, Loma Vista was referred to as the Southeast Village.

and the school complex. The current land use plan for this subarea is generally consistent with prior planning efforts, so there are no major increases or decreases in acreage for any one land use category; however, mixed use was disaggregated to three new land use categories called mixed use-business, mixed use-village, neighborhood commercial – aggregated area for these new land uses is nearly identical to the area associated with the prior mixed use classification. See **Table 3.2-4** for planned land uses summary.

Table 3.2-4: Loma Vista Land Uses

Land Use	SOI Boundary Land Uses		General Plan Boundary Land Uses	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	68	2%	68	2%
Very-Low Density Residential	87	3%	87	3%
Low Density Residential	1308	40%	1,308	40%
Medium Density Residential	376	11%	376	11%
Medium-High Density Residential	99	3%	99	3%
High Density Residential	113	3%	113	3%
Very-High Density Residential	21	1%	21	1%
Mixed Use – Village	70	2%	70	2%
Mixed Use – Business Campus	176	5%	176	5%
Neighborhood Commercial	9	<1%	9	<1%
General Commercial	24	1%	24	1%
Open Space	142	4%	142	4%
Public Facilities	72	2%	72	2%
Park	54	2%	54	2%
School	179	5%	179	5%
Water	87	3%	87	3%
Right-of-way	424	13%	424	13%
Total	**3,309**	**100%**	**3,309**	**100%**

<u>Northeast Village</u>

The Northeast Village is located in the northeast quarter of the study area, encompassing an area of approximately 9,032 acres. This subarea is bounded by the Indianola alignment on the east, Herndon and Shepherd Avenues on the south, Copper Avenue on the north and Big Dry Creek Reservoir on the west. Existing land use is comprised mainly of agriculture operations and open rangeland. Within the northeastern portion of this subarea, the flood plain for Big Dry Creek Reservoir encompasses about twenty-five percent (25%) of the total area.

Although a majority of this subarea has historically been associated with rural and agricultural settings, the City has considered this region for urbanization since mid-1990s. Prior planning documents are generally consistent with current land use plans for this subarea with only minor adjustment to acreages set aside for mixed use. Proposed land uses are likely to include following designations: general commercial; very-high, high, medium-high, medium, and low density residential; business campus and village mixed uses; open space; public facilities; right-of-way; rural residential; school and water. Given the approximately 2,200 acres associated with the flood plain for Big Dry Creek Reservoir, the open space designation still covers a majority of this subarea. See **Table 3.2-6** for a summary of land uses.

Table 3.2-5: Northeast Village Land Use

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agricultural	-	-	1	<1%
Rural Residential	-	-	17	<1%
Low Density Residential	106	10%	702	8%
Medium Density Residential	89	9%	1112	12%
Medium-High Density Residential	62	6%	640	7%
High Density Residential	58	6%	286	3%
Very-High Density Residential	11	1%	102	1%
Mixed Use – Village	127	12%	311	3%
Mixed Use – Business Campus	360	35%	360	4%
General Commercial	-	-	30	<1%
Open Space	54	5%	3944	44%
Public Facilities	-	-	11	<1%
Park	144	14%	206	2%
School	26	3%	336	4%
Water	-	-	264	3%
Right-of-way	-	-	710	8%
Total	**1,037**	**100%**	**9,032**	**100%**

Northern Rural

The Northern Rural subarea covers about 1,831 acres in the north central portion of the General Plan area and is positioned between the Northwest, Clovis, Northeast Triangle and Northeast subareas. The Northern Rural Village is bounded by Copper Avenue on the north; Sunnyside Avenue on the west; Shepherd Avenue on the south; and Enterprise Canal, Armstrong Avenue, and Big Dry Creek Reservoir on the east. This village consists primarily of rural residential land uses with minor farming operations scattered throughout. The major planned uses for this area will continue to include rural residential and agricultural designations. See **Table 3.2-6** for a summary of land uses.

Table 3.2-6: Northern Rural Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	-	-	391	21%
Open Space	-	-	84	5%
Right-of-way	-	-	64	3%
Rural Residential	-	-	1,292	71%
Total	**-**	**-**	**1,831**	**100%**

Northeast Corner

The Northeast Corner subarea covers approximately 3,001 acres and is located in the northeast portion of the study area. It is adjacent to the Northeast and Between Canals Villages and is bounded by Copper Avenue on the north, Friant-Kern Canal on the south, approximately the Indianola Avenue alignment on the west and Academy Avenue on the east.

This area currently consists of only agricultural land uses – similar to the Northeast Village. The planned land uses continue to include a majority of the acreage in agriculture; the remainder consists of newly introduced low, medium, medium-high, and high density residential, mixed use, open space, park, right-of-way, school and water land uses. **Table 3.2-7** identifies land uses for both the Sphere of Influence and General Plan boundaries.

Table 3.2-7: Northeast Corner Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	-	-	2,883	96%
Water	-	-	66	2%
Right-of-way	-	-	51	2%
Total	**-**	**-**	**3,000**	**100%**

Between Canals

Between Canals covers an area of approximately 7,488 acres and is located in the eastern portion of the General Plan area. The subarea is generally bounded by Nees and Herndon Avenues and the Friant-Kern Canal to the north, the Enterprise Canal and Bullard Avenue to the south, Locan, DeWolf, and Highland Avenues to the west and Academy Avenue to the east. Existing land uses primarily consist of rural residential and agricultural uses; they are shown in **Table 3.2-8**.

Table 3.2-8: Between Canals Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	-	-	864	12%
Low Density Residential	-	-	2	<1%
Planned Rural Community	-	-	17	<1%
Right-of-way	-	-	394	5%
Rural Residential	-	-	6,166	82%
Special Commercial	-	-	33	<1%
Very-Low Density Residential	-	-	1	<1%
Water	-	-	10	<1%
Total	**-**	**-**	**7,487**	**100%**

Southeast Corner

The Southeast Corner is a subarea located in the southeast corner of the General Plan encompassing approximately 4,643 acres of land. This subarea is adjacent to Loma Vista and Between Canals subareas and is bounded by Academy Avenue on the east, Shields Avenue on the south, McCall and Highland Avenues on the west, and the Enterprise Canal on the north.

This subarea is primarily comprised of agricultural and rural residential land uses with the distribution of these land uses anticipated to remain unchanged into the future. The primary concentration of single family residences is at Quail Lakes, a 375-acre master planned community located in the northwestern corner of this subarea. At build out, this development will be comprised of about 700 homes. See **Table 3.2-9** for a breakdown of land uses. Since the City is not planning on providing public utility service to this subarea it was excluded from the water master plan effort.

Table 3.2-9: Southeast Corner Land Uses

Land Use	SOI Boundary		General Plan Boundary	
	Area (ac)	Percentage of Total	Area (ac)	Percentage of Total
Agriculture	-	-	1,275	27%
Open Space	-	-	1	<1%
Planned Rural Community	-	-	250	5%
Right-of-way	-	-	231	5%
Rural Residential	-	-	2,679	58%
School	-	-	10	<1%
Special Commercial	-	-	137	3%
Water	-	-	59	1%
Total	**-**	**-**	**4,642**	**100%**

Notes:
1.Total acreage for the Quail Lakes Community is approximately 375 acres and is split between Open Space, Planned Rural Community, School, Water and a portion of Right-of-way.

Summary

Within the General Plan area, potable water facilities will be needed within five (5) of the nine (9) subareas. Full urbanization is planned for Clovis, Northwest Village, Loma Vista, Northeast Triangle and Northeast Village subareas with no urbanization planned for the remaining subareas. Collectively, residential land use designations comprise 53 percent of the total area or 25,100 acres (including rural residential). Within the urban residential aggregate total (disregarding rural residential), the low density residential designation accounts for 13 percent of the area or nearly 6,300 acres. **Table 3.2-10** presents a breakdown of land use designations within each subarea for existing and build-out conditions.

Table 3.2-10: Land Uses Summary

	Agriculture	Rural Residential	Very Low Density	Low Density	Medium Density	Medium High Density	High Density	Very High Density	Mixed Use - Village	Mixed Use - Business	Office	Industrial	Neighborhood Commercial	Special Commercial	General Commercial	Open Space	Public Facilities	Park	School	Water	Right-of-Way	Planned Rural Community	Total
SOI Boundary																							
Clovis	-	958	53	3,528	1,795	607	230	-	178	276	287	548	19	-	822	53	161	160	518	425	2,892	-	**13,510**
Northwest Village	-	-	104	241	954	290	78	-	418	63	-	-	14	-	-	-	9	80	-	160	218	-	**2,629**
Northeast Triangle	-	-	530	276	51	86	24	-	30	143	-	-	-	-	-	10	4	13	16	78	387	-	**1,648**
Loma Vista	68	-	87		376	99	113	21	70	176	-	-	9	-	24	142	72	54	179	87	424	-	**3,309**
Northeast Village	-	-	-	106	89	62	58	11	127	360	-	-	-	-	-	54	-	144	26	-	-	-	**1,037**
Northern Rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Northeast Corner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Between Canals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Southeast Corner	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	**0**
Total	**68**	**958**	**774**	**5,459**	**32,65**	**1,144**	**503**	**32**	**823**	**1,018**	**287**	**548**	**42**	**0**	**846**	**259**	**246**	**451**	**739**	**750**	**3,921**	**-**	**22,133**
Percent of Total	**<1%**	**4%**	**3%**	**25%**	**15%**	**5%**	**2%**	**<1%**	**4%**	**5%**	**1%**	**2%**	**<1%**	**<1%**	**4%**	**1%**	**1%**	**2%**	**3%**	**3%**	**18%**	**-**	**100%**
General Plan Boundary																							
Clovis	-	958	53	3,528	1,795	607	230	-	178	276	287	548	19	-	822	53	161	160	518	425	2,892	-	**13,510**
Northwest Village	-	-	104	241	954	290	78	-	418	63	-	-	14	-	-	-	9	80	-	160	218	-	**2,629**
Northeast Triangle	-	2	530	445	151	110	24	-	44	143	-	-	-	-	-	49	4	35	32	78	431	-	**2,078**
Loma Vista	68	-	87	1,308	376	99	113	21	70	176	-	-	9	-	24	142	72	54	179	87	424	-	**3,309**
Northeast Village	1	17	-	702	1,112	640	286	102	311	360	-	-	-	-	30	3,944	11	206	336	264	710	-	**9,032**
Northern Rural	391	1,292	-	-	-	-	-	-	-	-	-	-	-	-	-	84	-	-	-	-	64	-	**1,831**
Northeast Corner	2,883	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	51	-	**3,000**
Between Canals	864	6,166	1	2	-	-	-	-	-	-	-	-	-	33	-	-	-	-	-	10	394	17	**7,487**
Southeast Corner	1,275	2,679	-	-	-	-	-	-	-	-	-		-	137	-	1	-	-	10	59	231	250	**4,642**
Total[3]	**5,482**	**11,114**	**775**	**6,226**	**4,388**	**1,746**	**731**	**123**	**1,021**	**1,018**	**287**	**548**	**42**	**170**	**876**	**4,273**	**257**	**535**	**1,075**	**1,149**	**5,415**	**267**	**47,518**
Percent of Total	**12%**	**23%**	**2%**	**13%**	**9%**	**4%**	**2%**	**0%**	**2%**	**2%**	**1%**	**1%**	**0%**	**0%**	**2%**	**9%**	**1%**	**1%**	**2%**	**2%**	**11%**	**1%**	**100%**

3.3 Conversion of Agricultural Land

Clovis was founded and initially developed due to logging and the lumber industry in the late 1800s. Following the logging era, the predominant land use in the Clovis area became agriculture with operations ranging from small farms to large scale agricultural operations. Since the 1920s land use in the area has slowly shifted from agriculture to residential, commercial and industrial uses with several periods of rapid growth noted in the 1960s, 1970s, and 2000s. Generally, smaller farms are located near the City limits and rural residential areas while larger agricultural operations are in the unincorporated County portion of the study area. Recently, shifting market conditions have led to conversion of typical pasture lands into highly profitable tree crops, specifically citrus and nuts.

Historically, lands within International and Garfield Water Districts were cultivated for agricultural uses. Crops grown commercially have been categorized into various groups consisting mainly of:

- Alfalfa and Pasture
- Almonds
- Mediterranean Orchard
- Vineyard
- Deciduous Orchard
- Miscellaneous Field Crops

Of the 47,520 acres within the study area, approximately 15,000 are cultivated (see **Figure 3.3-1**). With continued development, the 15,000 acres of agricultural lands are expected to be reduced to less than 5,500 acres. As development of land occurs, it is expected that the land adjacent to the City center will be urbanized first.

All lands within the Garfield and International Water Districts rely on and have the ability to utilize surface water; within the FID, this is not the case. Service to rural residential land is based primarily on a parcel's proximity to FID distribution facilities which were in existence prior to subdividing larger parcels into smaller ones. A portion of the lands within FID received surface water through water service contracts while an estimated 10,000 acres of urban and agricultural lands within the Study Area do not have active water service contracts; these properties are served by groundwater pumping only. The remainder water service lands are served by pumping from ditches or by gravity flow; however a portion of the lands classified as water service lands do not actually take delivery of District irrigation water, particularly in areas surrounding Clovis. Some of these parcels have historically never diverted water, others prefer pumping shallow groundwater, and some on drip irrigation generally prefer groundwater, due to scheduling and filtering considerations. **Figure 3.3-2** shows the irrigation district boundaries and the developed and undeveloped parcels within the district boundaries.

Figure 3.3-1: Agriculture Lands

Figure 3.3-2: Irrigation Districts and Undeveloped Lands

3.4 Population Projections

The City has experienced rapid growth beginning in the late 1960s through present. In the last 25 years, population has doubled from 54,211 in 1990 to a 2016 value of 108,039. **Table 3.4-1** summarizes how population has changed from 1920 to 2015 and presents annual growth data from 2000 to present.

Table 3.4-1: City of Clovis Historic Population

Year[1]	Population	Growth	Year	Population	Growth
1920	1,157	-	2004	80,111	5.7%
1930	1,316	-	2005	84,552	5.5%
1940	1,626	-	2006	88,239	4.4%
1950	2,766	-	2007	90,155	2.2%
1960	5,546	-	2008	92,484	2.6%
1970	22,133	-	2009	93,629	1.2%
1980	33,021	-	2010	95,631	2.1%
1990	49,300	-	2011	97,218	1.7%
2000	68,516	-	2012	98,611	1.4%
2001	69,992	2.2%	2013	99,983	1.4%
2002	72,514	3.6%	2014	102,188	2.2%
2003	75,805	4.5%	2015	104,339	2.1%

As indicated above, the average rate of growth for the City has been 2.9% since 2000; however, it is important to note the most recent years include the Great Recession; the effect on the City's growth is reflected most in years 2009 through 2013 when growth slowed to an average rate of 1.7%. The City's General Plan Environmental Impact Report identifies population projections for the City with a Projected 2035 population of 184,100 and ultimate buildout of 294,300, which reflects continued slowing of growth from the historic average.

The City provides water to one major area not within the City limits, and therefore not quantified in the population figures from the Department of Finance or the table above; Tarpey Village is considered fully developed with an average population of 3,888. No growth is applied to the Tarpey Village population for the purposes of projecting future service area population numbers.

The service area population projections for this Study are based on the 2016 population estimate of 108,039, a growth rate of 2.9% for the City up to 2021, a 2.5% growth rate from 2022 to 2035, and 3,888 non-growth population for Tarpey Village. Using these assumptions, the population projections for the service area are expected to increase from a current population of 111,927 to an estimated population of 180,001 in 2035. Refer to Table 3.4-2 for a summary of projections, at five year intervals, for the next 20 years. The historical and projected populations are also illustrated below in **Figure 3.4-1**. These population numbers, in conjunction with land use based water demands will be used to develop the projected City Water Demands discussed in Chapter Five.

Table 3.4-2: City of Clovis Projeted Service Area Population

Year	Population
2020	125,015
2025	141,467
2030	159,546
2035	180,001

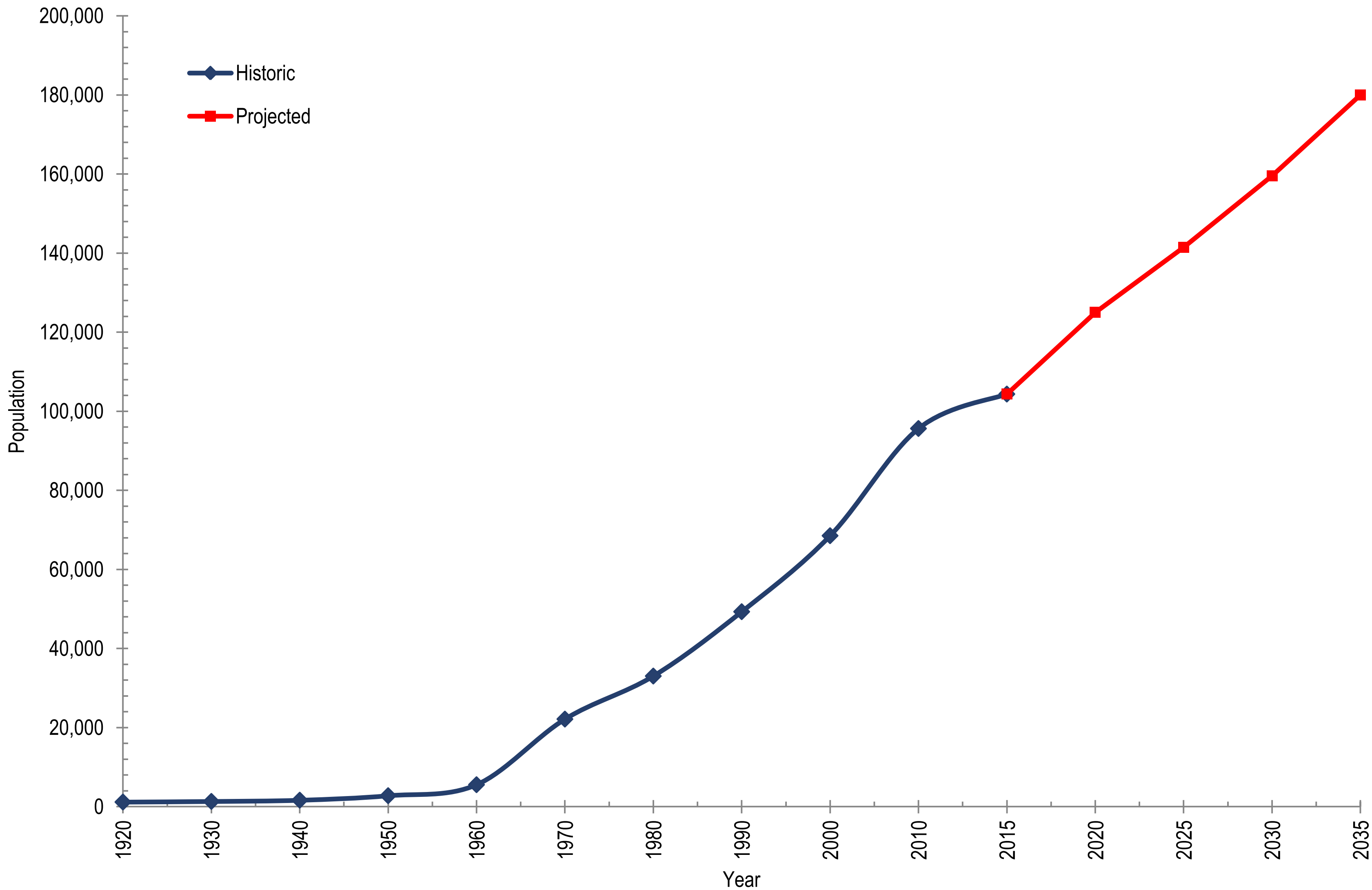


Figure 3.4-1: City of Clovis Service Area Population

4 Existing Water System

This purpose of this chapter is to provide a summary discussion of the City's existing water system, including wells, surface water treatment facilities, pressures zones, booster pump stations, storage facilities, and distribution system. Details about the groundwater aquifer and surface water sources are discussed in Chapters 6 and 7, respectively.

4.1 Service Area

The City of Clovis water service area largely aligns with the City's annexed boundaries. The City also serves an old county waterworks district known as Tarpey Village, which became part of the water system through an agreement with Fresno County in 1989. The entire service area is shown in **Figure 4.2-1**. The existing service area is comprised of nearly 14,860 acres of incorporated city boundaries[4], and another approximate 515 acres for Tarpey Village. Topography across the existing service area is seemingly flat, though it slopes from the northeast to the southwest with a change in elevation of about 90 feet. The elevation difference across the service area is sufficient enough to justify the use of pressures zones to enhance system operations. Being within a semi-arid region, peak production occurs in the summer months generally from June through September.

4.2 Water Supply Sources

As the City continues to grow, reliable water supplies become increasingly difficult to maintain or develop. The City has recognized the need to be proactive in managing the demand curve and has constructed state of the art projects to meet the growing demands, such as surface water and recycled water treatment plants. The following discussion provides a brief synopsis of the existing facilities used to meet current system demands.

4.2.1 Groundwater Wells

In order to meet system demands, the City continues to rely primarily on groundwater despite the construction of the surface water treatment plant (SWTP) which began operation in 2004. Groundwater well production has of recent history been tracked as two areas of production, the City of Clovis and Tarpey Village. **Figure 4.2-2** and

Table 4.2-1 show groundwater production and surface water production from 1984 to 2015. As can been seen from the figure and table, for the time period from 2005 to 2015 groundwater production has made up approximately seventy-two percent (72%) of total combined production. In the most recent completed year, 2015, the groundwater percentage was down to sixty-one (61%) of total production. The combined groundwater well system (City & Tarpey) consists of 42 wells, of which 6 have wellhead treatment, 2 are in standby with water quality issues, and 5 are inactive due to being dry or otherwise unusable. Additionally,

[4] Area as noted in City of Clovis, Draft Program Environmental Impact Report, Volume I: Draft PEIR and Appendix A, General Plan and Development Code Update, June 2014.

there is one well site yet to be constructed though the well has been drilled, which is Well 39. This well will likely require treatment for manganese. **Figure 4.2-3** shows well locations throughout the City and their magnitude of production.

Table 4.2-1: Historic Groundwater and Surface Water Production

Year	Clovis Wells	Tarpey Wells	Surface Water Treatment Plant	Total	% Groundwater	% Surface Water
1984	9,512	2,016	-	11,528	100%	0%
1985	10,532	1,939	-	12,471	100%	0%
1986	10,085	1,974	-	12,059	100%	0%
1987	10,508	1,877	-	12,386	100%	0%
1988	11,063	1,774	-	12,837	100%	0%
1989	10,999	1,477	-	12,476	100%	0%
1990	11,964	1,613	-	13,577	100%	0%
1991	11,907	1,526	-	13,433	100%	0%
1992	12,695	1,502	-	14,197	100%	0%
1993	13,853	1,459	-	15,312	100%	0%
1994	14,511	1,500	-	16,011	100%	0%
1995	14,707	1,446	-	16,153	100%	0%
1996	15,434	1,679	-	17,112	100%	0%
1997	17,099	1,627	-	18,726	100%	0%
1998	15,177	1,331	-	16,508	100%	0%
1999	17,270	1,324	-	18,593	100%	0%
2000	18,059	1,294	-	19,353	100%	0%
2001	18,890	1,304	-	20,194	100%	0%
2002	20,024	1,252	-	21,276	100%	0%
2003	21,026	1,573	-	22,599	100%	0%
2004	21,418	1,616	1,317	24,350	95%	5%
2005	17,319	920	5,894	24,134	76%	24%
2006	17,709	833	6,882	25,424	73%	27%
2007	21,415	1,061	4,947	27,423	82%	18%
2008	20,603	738	6,418	27,759	77%	23%
2009	18,381	705	7,092	26,178	73%	27%
2010	17,504	695	6,535	24,734	74%	26%
2011	15,999	542	7,390	23,932	69%	31%
2012	17,727	629	7,753	26,110	70%	30%
2013	19,502	657	6,962	27,121	74%	26%
2014	14,988	541	9,538	25,067	62%	38%
2015	11,902	287	7,839	20,028	61%	39%

Figure 4.2-1: Water System Service Area

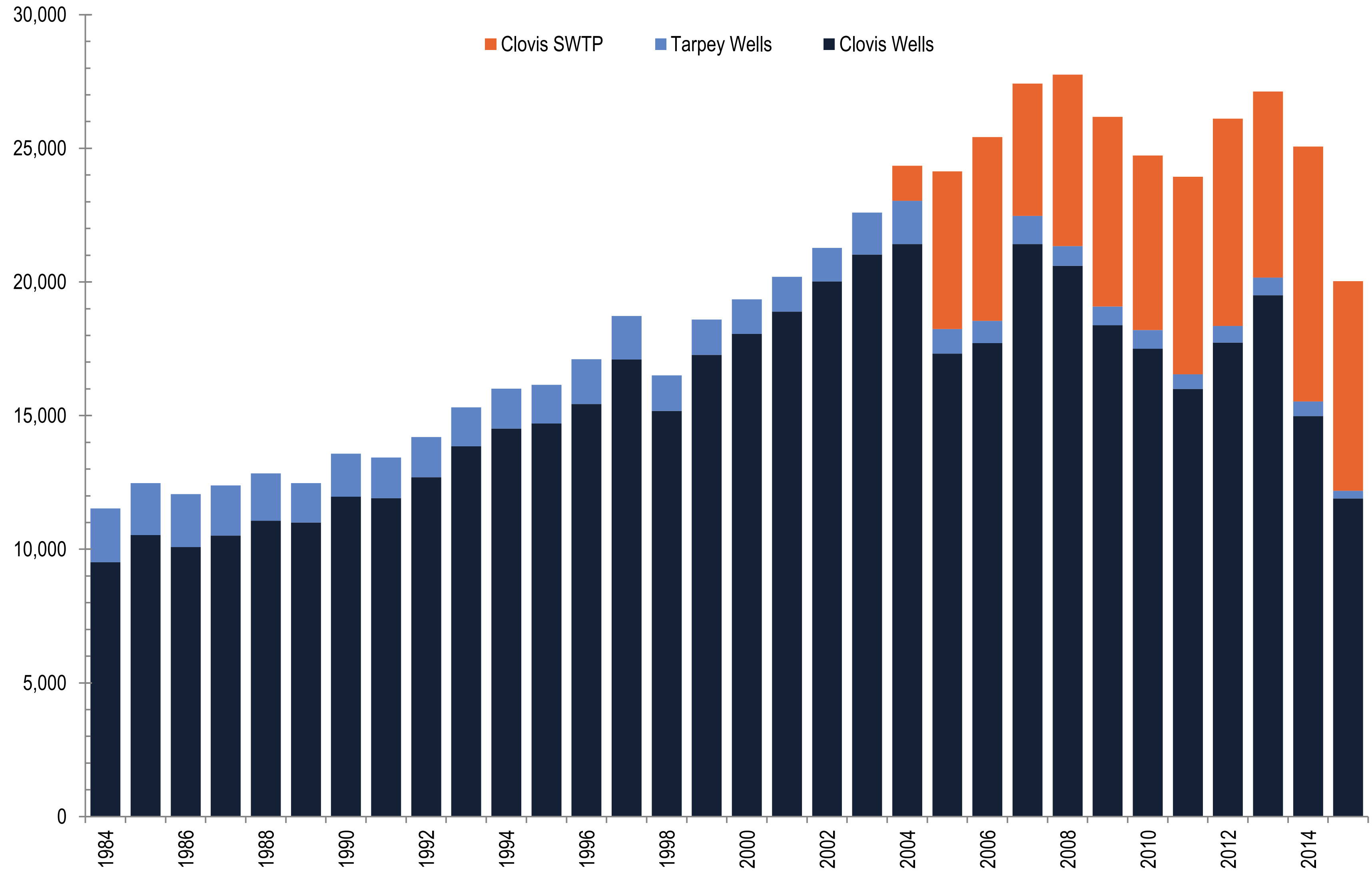


Figure 4.2-2: Historic Groundwater and Surface Water Production

Figure 4.2-3: Existing Wells and Relative Production

Table 4.2-2 has a complete inventory of the existing wells that make up the Clovis municipal well system, and provides approximate well capacity, status, and type of wellhead treatment, if any. The largest production well is Well 26 at 2,200 gpm, and the lowest production well is Well 23 at 300 gpm. Of the 35 active wells, average production is 1,200 gpm. Predominantly, the municipal wells are grouped along the westerly edge of town, bounded by Willow, Dakota, Sunnyside, and Nees Avenues. All but seven wells are located within this 9 square mile area.

Since incorporation in 1912, the City has relied on groundwater to meet its potable water needs. Even today with the SWTP in operation, groundwater still provides about seventy-two percent (72%) of the overall water supply. Depending on the type of well casing material and water characteristics a well may have a service life of 60 to 70 years. Assuming a 60 year life expectancy, wells constructed prior to 1955 would currently be slated for replacement. Four wells fit this criterion: Well 3 (1948); Well T-1 (1950); Well T-2 (1951); and Well T-3 (1955); however all four have gone dry and are no longer in use. The next series of wells to evaluate for replacement would be those that reach the 60 year life expectancy value in the next five years, which includes only Well T-5 (1959). The 60 year life expectancy value is only a guide and each well will require a field assessment to determine when replacement is appropriate. In general, based on the age of the City's well field, it would appear with an appropriately paced replacement program the municipal water well infrastructure is in good condition.

The Tarpey Village area was subdivided from about 1950 through 1955[5]. Based on the City's historical data, the Tarpey Village service area had eight wells when it was incorporated into the City's system, and served an approximate customer base of 4,700 people at that time. Since acquisition, two of the wells have been destroyed and three have gone dry, leaving three remaining in use. This is a particular concern because the County-City agreement for system acquisition stipulated the former county served residents do not have to be metered unless the State or Federal government requires it. Presently, however, over 900 of the 1,350 residential services are on a meter. So far the City has been largely successful in getting residents within the Tarpey Village to pay for meter installations through incentive pricing. As the cost for meter installations continues to rise however the number of residents requesting installations has tapered off. Billing for the residents that are not metered is based on production of the wells within the Tarpey area (excluding T-5) and a master meter (with bi-directional flow measurement capability) measures inflows and outflows with all metered residential consumption being subtracted. The tallied difference is then spread amongst these unmetered homes. Each unmetered residence is allocated 32,500 gallons per month, and anything above that is charged at a higher unit rate. By State law all individual customers will be required to be metered by 2025.

[5] Noted dates are recordation dates of the tract maps that created the Tarpey Village subdivisions.

Table 4.2-2: Existing Well Inventory

ID	Location	Capacity (gpm)	Standby Capacity[1] (gpm)	Treatment	Notes
2A	313 Fifth Street	1,300	-	-	Active
3	1190 Fifth Street	-	-	-	Inactive – Dry
4AA	3300 Lind Ave	1,330	-	-	Active
5A	Barstow & Pollasky	1,560	-	-	Active
7A	1000 Villa	2,000	-	-	Active
8A	294 N. Villa	1,592	-	GAC	Active
10	2698 Peach	920	-	-	Active
11	1722 Fowler	-	-	-	Inactive 2014
12	900 Gettysburg	1,243	-	-	Active
14	198 N. Peach	-	1,300	-	Standby for DBCP
15A	599 Timmy	1,399	-	-	Active
16	3004 Armstrong	1,073	-	Mn	Active
17	1680 Willow	1,247	-	-	Active
18	3405 Clovis	717	-	-	Active
20	1103 Armstrong	-	400	-	Standby for Fe/Mn
21	640 W. Alluvial	904	-	GAC	Active
22	842 Alluvial	642	-	-	Active
23	700 N. Hughes	313	-	-	Active
24	744 N. Sunnyside	770	-	-	Active
25	105 W. Nees	863	-	-	Active
26	850 N. Peach	2,207	-	-	Active
27	611 N. Peach	859	-	GAC	Active
28	399 W. Shaw	1,874	-	-	Active
29	820 W. Pico	902	-	-	Active
30	1120 N. Sunnyside	946	-	-	Active
31	4201 N. Leonard	648	-	-	Active low use (Mn)
32	1494 Cole	1,500	-	-	Active
33	2503 Nees	-	-	-	Inactive – Sand
34	1657 N. Willow	1,275	-	-	Active
36	685 W. Nees	1,132	-	GAC	Active
37	305 N. Minnewawa	1,333	-	-	Active
38	221 N. Villa	1,699	-	-	Active
39	Magill & Willow	-	-	-	Construction on hold (Mn)
40	2819 Fowler	1,224	-	-	Active low use (Mn)
41	811 N. Minnewawa	1,500	-	-	Active
42	Holland & Peach	2,065	-	-	Active
43	Rodeo Grounds	1,772	-	-	Active
T-5	5789 E. Tarpey	1,079	-	-	Active
	Clovis Capacity	**39,888**	**1,700**		
T-1	4254 N. Minnewawa	-		-	Inactive – Dry
T-2	4205 N. Hammel	-		-	Inactive – Dry
T-3	5353 E. Bernadine	-		-	Inactive – Dry
T-6	4189 N, Hammel Way	860		GAC	Active
T-7	5598 E. Ashlan	593		-	Active
T-8	5435 E. Ashlan	639		-	Active
	Tarpey Capacity	**2,092**	**0**		
	Total System Capacity	**41,980**	**1,700**		

Notes:
1. Wells that may be operated during emergencies but will produce lower quality water.
2. Information obtained from the City of Clovis.

4.2.1.1 Wellhead Treatment

As was previously mentioned, six of the existing municipal water wells have wellhead treatment. One well is treated for elevated levels of manganese, and five wells are treated for the contaminant 1,2-Dibromo-3-chloropropane (DBCP). Manganese is a secondary contaminant, which is not health based, but has a maximum contaminant levels (MCL) set for aesthetic quality. Elevated concentrations of manganese may cause black staining and a bitter metallic taste. Typical treatment options for wells with elevated manganese include sequestering, ion exchange, and oxidation and filtration. DBCP is a banned soil fumigant that was used to control nematodes, but was found to cause sterility in men and there is evidence it may potentially cause cancer with life time exposure above the MCL. Further discussion of water quality issues is included in Chapter 6 - Groundwater Supply. Typical treatment for wells impacted by DBCP is granular activated carbon (GAC). The treatment process, in brief, consists of passing the contaminated water at a prescribed loading rate through a pressure vessel with a bed of GAC that adsorbs the contaminant, producing clean potable water. The cumulative production capacity of the City's GAC treated wells is 5,350 gpm. As is shown in Table 4.2-3 annual water production from GAC treated wells typically averages about 3,960 AF. Utilization of the GAC treated wells varies seasonally, with the lowest production occurring in February and the highest production occurring in July. The peak months of operation run from May through September.

Table 4.2-3: GAC Wellhead Treatment Average Monthly Production

Month	Volume (AF)	Month	Volume (AF)
January	233	July	453
February	177	August	446
March	244	September	379
April	308	October	322
May	396	November	310
June	405	December	237

Notes:
1. Data based on well production records obtained from the City of Clovis.
2. Data represents average monthly values from 2004 to 2014.

The presence of iron and manganese minerals in groundwater is quite common, however depending on local geology may have concentrations in excess of secondary contaminant levels, which are generally set for aesthetic purposes. Wells 16 has elevated concentrations of manganese and Well 20 has elevated concentrations of both iron and manganese, making both wells candidates for treatment. Well 16 is equipped with a Filtronics manganese treatment system; and Well 20 is in standby mode and used to monitor system pressure for Reservoir 3. The City also reports Wells 31 & 40 have elevated manganese levels and subsequently have reduced the use of these wells.

4.2.2 Surface Water Treatment Facility

In 2004, the City completed construction of a 15 million gallon per day (MGD) surface water treatment plant (SWTP), adjacent to the Enterprise Canal, just south of Bullard Avenue on Leonard Avenue. This plant represented the City's departure from its sole reliance on groundwater and was its first step in developing a diversified water supply portfolio. The SWTP uses membrane filtration along with several supporting unit processes designed to ensure compliance with state and federal water quality regulations. Ultimate treatment capacity of this facility is planned at 45 MGD. During the time period of 2005 through 2015, the SWTF had an average annual production of 6,500 AF (. The plant is typically operated from January through December each year (see **Table 4.2-4**) and is subject to the annual Fresno Irrigation District (FID) canal shutdowns in the month of November. The months of August and September, historically, have been the highest production months for the plant. Although the plant was previously rated for 15 MGD, historic production only saw a monthly averaged daily maximum production of 10 MGD. Full utilization of the plant had been hindered for several years due to long standing design issues. In 2014, treatment capacity at the SWTP was increased to 22.5 MGD with the addition of four new membrane treatment racks. The necessary retrofits were also completed to correct the earlier operational issues. With the plant improvements the City realized a forty-three percent (43%) increase in treated surface water production over that of the prior nine year period. Peak output for 2014 occurred in the months of July and August at an average value of 16 MGD. Production during 2015 was reduced due to surface water supply limitations as a result of the drought and State mandated demand reductions.

Table 4.2-4: Annual SWTP Production

Year	Volume (AF)	Year	Volume (AF)
2004	1,300	2010	6,500
2005	5,900	2011	7,400
2006	6,900	2012	7,800
2007	4,700	2013	6,900
2008	6,400	2014	9,500
2009	7,100	2015	7,800

Notes:
2004 does not represent a full year of production data because the SWTP come online July of that year.
Data based on water production records obtained from the City of Clovis.

Table 4.2-5: Monthly Water Production from the SWTP for 2004 to 2015

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	0	0	0	0	133	367	481	336	0	0	1,300
2005	64	144	228	314	486	420	756	951	1,071	1119	029	315	5,900
2006	401	412	422	458	887	828	923	789	825	675	7	255	6,900
2007	357	308	446	437	204	534	627	590	571	576	0	0	4,700
2008	97	168	321	428	739	722	750	927	1,055	1031	0	180	6,400
2009	422	340	464	609	825	938	1,004	1,002	828	660	0	0	7,100
2010	41	336	395	476	608	723	925	1,053	1,019	825	0	133	6,500
2011	334	498	403	774	857	787	912	933	901	826	165	0	7,400
2012	350	481	541	586	966	950	997	964	965	862	0	91	7,800
2013	378	348	453	470	769	992	1,035	1,041	949	485	0	11	6,900
2014	262	402	520	624	743	1,170	1,479	1,549	1,376	1,259	0	155	9,500
2015	366	373	440	441	483	913	1,218	1,268	1,127	894	0	320	7,800
Average	**260**	**320**	**390**	**470**	**630**	**750**	**900**	**950**	**930**	**800**	**20**	**120**	**6,500**

Notes:
Data obtained from City of Clovis monthly water production spreadsheets.
Average values rounded to the nearest ten and totals were rounded to the nearest hundred.

4.2.4 Recycled Water Treatment Facility

Continuing an aggressive and proactive pursuit to develop a diverse and sustainable water supply, the City finished construction of a recycled water treatment facility in 2009[6]. This facility, located at Ashlan and McCall Avenues, has a current production capacity of 2.8 MGD and a buildout production capacity of 8.4 MGD; however, the facility is limited biologically by design to approximately 2.3 MGD but could accommodate up to 2.8 MGD on occasion. The ultimate planned production of this facility will be built in three phases at 2.8 MGD each[7]. Each of the three phases of treatment facility construction will also consist of a 3.08 MG storage tank. Build-out of the plant is projected to occur in approximately 2039, with full utilization of plant capacity subsequently occurring after 2040. The initial 2.8 MGD phase was constructed at a cost of $40 million through a Design-Build-Operate (DBO) contract. Under this contract, the DBO contractor will operate the facility through 2018[8].

The recycled water is and will continue to be used to offset potable water historically applied to public green spaces. The City has identified potential use areas such as parkways, numerous schools, parks, public facilities, cemetery, Fresno State agricultural fields, as well as landscaping along State Route (SR) 168 through an agreement with Caltrans. At the planned phases for this facility, annual water production would be: Phase 1 - 3,140 AF; Phase 2 - 6,270 AF; Phase 3 - 9,410 AF. Projected utilization of the treated water is optimal in the summer months and low during winter months, which means up to about fifty percent (50%) of the recycled water generated by the ST/WRF could be used to offset potable demand. The remainder of the treated recycled water that is not used is discharged directly to either the FID Fancher Creek Canal No. 6 or the Fresno Metropolitan Flood Control District (FMFCD) Little Dry Creek Diversion Channel. For all three phases, the projections anticipate there are no or nearly negligible demands in the months of January, February, and December, so full plant production during these months is anticipated to be discharged to the FID and/or FMFCD systems. The City anticipates evaluating and potentially utilizing excess recycled water to supplement surface water for recharge at the City's recharge facility at Marion and Alluvial Avenues.

The disinfected tertiary-treated water is conveyed by a backbone transmission main that runs generally northward along the eastern boundary of Clovis. Lateral mains will be built-off the backbone transmission main to feed use areas as they develop. There are two outfall structures, as previously described, at both the southern and northern terminus of the transmission main.

4.3 Distribution System and Storage Facilities

The key to assuring water is delivered to the City's customers is largely dependent on an appropriately sized distribution system with adequate storage to meet peak demands. This section will briefly discuss the City's water distribution system and storage facilities.

[6] City of Clovis Department of Public Utilities Recycled Water webpage.

[7] Recycled Water Master Plan, Provost & Pritchard Consulting Group, August 2016.

[8] City of Clovis Recycled Water Brochure, City of Clovis DPU webpage.

4.3.1 Water System Pressure Zones

As was previously mentioned in Section 4.1, the topography across the city is generally sloped from the northeast to the southwest. To optimize water system delivery and system pressures, the City created two pressure zones. Zone 1 covers the area from the southwest corner of the City and extends northerly, northeasterly, and easterly towards the Enterprise Canal. The boundary between Zone 1 and Zone 2 generally follows the 380-foot ground surface elevation contour line, and is more particularly described as following Clovis Avenue south of Shepherd Avenue to SR 168; then easterly along SR 168 to the Enterprise Canal; then easterly and south adjacent to the canal to Herndon Avenue; then south on Locan Avenue to Ashlan Avenue. This alignment takes advantage of limited pipeline crossings of the Enterprise Canal, Dry Creek and SR 168. The three pressure zone boundary crossings, at Alluvial, Sunnyside, and Barstow Avenues, are equipped with check valves to maintain the zone integrity and allow water across if extremely low pressures occur in Zone 2. To aide pressure and flow management a series of pressure sustaining valves were installed along Locan Avenue. Table 4.3-1 below provides the location of each PRV along Locan Avenue.

Table 4.3-1: Pressure Sustaining Valve Locations

Valve ID	Location
PSV-1	SW Corner of Bullard and Locan
PSV-2	NE Corner of Barstow & Locan
PSV-3	NE Corner of Shaw & Locan
PSV-4	SE Corner of Gettysburg & Locan
PSV-5	SE Corner Ashlan & Locan

Zone 2 covers the area east of the previous described boundary, which includes the northeasterly corner of the Clovis Village, the Northeast Triangle Village, and the Loma Vista Village. As development occurs in the future further northeast, additional pressure zones are plausible.

4.3.2 Water Storage Facilities

The City has invested heavily in constructing water storage facilities to meet peak demands as it continues to grow. To date there are four active reservoirs, consisting of one elevated tank and 3 at-grade reservoirs. The elevated tank is located in southwest Clovis at Letterman Memorial Park and has a capacity of 500,000 gallons, while the at-grade reservoirs are predominantly located in the northeastern and eastern portion of Clovis. The reservoir at Letterman Memorial Park is above the hydraulic grade line of the system and does not typically operate on the system except in period of high demand. As seen in Table 4.3-2 below, the combined nominal storage capacity of these four reservoirs is 7 million gallons.

Table 4.3-2: Water Storage Reservoirs

Reservoir ID	Location	Gross Capacity (MG)	Notes
R-1	Downtown Clovis	0.065	Decommissioned
R-2	Letterman Park (Barstow & Villa)	0.5	Elevated Tank
R-3	Armstrong & Tollhouse	2.0	At Grade
R-4	Burl Avenue, South of Nees Avenue	2.0	At Grade
R-5	SWTP	2.5	At Grade
Total		**7.0**	

4.3.3 Booster Pump Station

To meet system pressure requirements in the northeast portion of the water service area a booster pump was installed on Armstrong Avenue adjacent to and north of SR 168. This facility draws water from Zone 1 and pushes it through the 14 inch main northerly to new development areas in Zone 2. Production capacity of the pump station ranges from 400 to 1,200 gpm.

4.3.4 Water Transmission System

The City's primary large diameter water transmission mains are required to convey significant volumes of water away from the SWTP. A portion of the transmission mains run south from the SWTP in Leonard Avenue providing water to the Loma Vista Village and eastern edge of the Clovis Village. The transmission mains also run west in Bullard Avenue from the SWTP to Locan Avenue and then north in Locan to Nees Avenue and then west in Nees to Minnewawa Avenue. This northerly transmission main feeds the Northeast, Northwest Villages and the northern portion of the Clovis Village. The lines range from 16 to 42 inches in diameter, decreasing in size as they traverse away from the SWTP. **Figure 4.3-1** shows the City's major transmission mains and **Table 4.3-3** provides a tally of lengths for each size pipe.

Table 4.3-3: Existing Transmission System

Pipe Diameter (inches)	Length (feet)
16	63,100
18	11,400
20	700
24	16,400
30	4,100
36	200
42	17,500
Total	**113,400**

Notes:
Lengths based off GIS data provided by the City of Clovis.

Figure 4.3-1: Major Existing Infrastructure

4.3.5 Water Distribution System

The City's distribution system is composed of small diameter water mains consisting largely of 6", 8" and 12" diameter pipes. A detailed breakdown is provided in **Table 4.3-4** below, which shows nearly one-half of the distribution system, is comprised of 8" diameter pipes.

Table 4.3-4: Existing Distribution System

Pipe Diameter (inches)	Length (feet)
4 and Less	84,700
6	698,300
8	1,203,500
10	52,000
12	487,700
14	10,600
Total	**2,537,000**

Notes:
Lengths based off GIS data provided by the City of Clovis.
Lengths for individual pipe sizes rounded to the nearest 100 feet.
Total length rounded to the near 1,000 feet.

4.3.6 Emergency Power Generators

In the event of local or citywide electrical power outages, the City has installed emergency electrical power generators at 12 well sites (one is at an inactive well site), 2 reservoirs, the Armstrong Booster Pump Station (BPS), and the SWTP. See **Figure 4.3-2** for a location map of facilities equipped with emergency power generators. The combined production capacity of the active well sites is about 13,550 gpm, which would yield about 19.5 MGD. Emergency output from Reservoirs 3 & 4 would be approximately as much as 6,500 gpm; and transmission of water from Zone 1 to Zone 2 by the Armstrong Booster Pump Station would be as much as 1,200 gpm if conditions were favorable. The SWTP also has an emergency power generator that was capable of powering one-half of the original plant's capacity of 7.5 MGD[9] (5,200 gpm). Table 4.3-5 provides a list of sites equipped with emergency power generators.

The City's average day demand for the last five years has been about 22.7 MGD, and the average daily use in February for the same period has been about 11.2 MGD. The month of February is typically the lowest demand period each year, coinciding with minimal exterior landscape irrigation. As such, February serves as an indicator of minimum household needs during emergency situations. Using these values may be one approach to determining minimum back-up power generation needs. As demonstrated through the information shown in Table 4.3-5, should the largest emergency electrical power generator (i.e. the SWTP) not be operational during an emergency the number of existing equipped well sites is capable of meeting wintertime demand production capacity in the event of a system-wide blackout.

[9] SWTP emergency power generator capacity provided by Lisa Koehn in email June 18, 2015.

Figure 4.3-2: Facilities Equipped with Emergency Power Generator Units

Table 4.3-5: Facilities Equipped with Emergency Power Generator Units

Site	Location	Pressure Zone	Capacity (gpm)[4]	Fuel Type
Well 4AA	Lind n/o Dakota	1	1,330	Diesel
Well 8A	Villa s/o Herndon	1	1,592	Diesel
Well 10	Peach n/o Gettysburg	1	920	Diesel
Well 11	Fowler n/o Shaw	1	Inactive	NG
Well 12[1]	Gettysburg e/o Clovis	1	1,243	Diesel
Well 21	Alluvial w/o Willow	1	904	Diesel
Well 24	Sunnyside n/o Herndon	1	770	NG
Well 26	Alluvial e/o Peach	1	2,207	Diesel
Well 27	Peach n/o Herndon	1	859	Diesel
Well 28	Shaw w/o Villa	1	1,874	Diesel
Well 29	Willow n/o Gettysburg	1	902	Diesel
Well 30	Sunnyside s/o Nees	1	946	Diesel
SWTP[2]	Leonard s/o Bullard	2	≈ 5,200	Diesel
Armstrong BPS	Armstrong & SR 168	2	400 - 1,200	Diesel
Reservoir 3	Armstrong & Tollhouse	1	2,500	Diesel
Reservoir 4	Burl Ave s/o Nees Ave	2	4,000	Diesel
	Total		**25,200**	

Notes:
Well 12 equipped with a mobile generator. See June 9, 2015 e-mail from Lisa Koehn.
Emergency generator at SWTP is only capable of powering a single treatment train (7.5 MGD).
Total production excludes the Armstrong Booster Pump Station since this facility is not a source of supple and only moves water from Zone 1 to Zone 2.
See June 9, 2015 e-mail from Lisa Koehn regarding information about a mobile generator at Well 12 and capacity of an emergency generator at the SWTP.
Total capacity rounded to the nearest 1,000 gpm.

4.3.7 Emergency Interties

Another source of water available to the City during an emergency could be provided by the City of Fresno through a system intertie. At present no such connection exists, but both cities have been working on constructing an intertie that will be capable of conveying water from Clovis to Fresno and vice versa in the case of emergency. An alignment has been agreed to by both cities and the southern intertie has been constructed. The alignment commences at Gettysburg and Leonard Avenues and runs south in Leonard to Shields Avenue; then west in Shields to Locan Avenue; then north a short distance to where it ties into a pump station on the west side of Locan Avenue. The interconnection pipeline is 16" diameter and capable of conveying about 3,500 gpm. The original intent of the intertie is to provide the City of Fresno water augmentation through a cooperative agreement for a specified period, and then the intertie would be kept for emergency purposes. The construction of the southern intertie is complete and Fresno is completing some SCADA and permitting work before utilizing the connection. The northern intertie location has been determined at Behymer and Willow Avenues but construction has not begun.

5 Water Demands

This chapter reviews existing water demands for the City utilizing both the per capita and land use based approaches. Existing demands are based on information provided by the City. Forecasts of future demands are then made based on both of these approaches and compared. Water system response to peak period conditions is also discussed.

5.1 Historic Water Use

5.1.1 Historic Water Production

Potable water production consists of municipal groundwater wells and a surface water treatment plant (SWTP). **Figure 4.2-2** shows yearly production since 1984 and what fraction of the total production was provided by wells and the SWTP; the well production is separated into City wells and those in the Tarpey Village area. Production from these facilities is tracked and recorded by the City and summarized in **Table 5.1-1**. Review of this table shows water production steadily increased until 2008 and then dropped until a one-year increase in 2013.

As can be seen in **Table 5.1-1**, water production has transitioned from being entirely on groundwater to being one of conjunctive use, relying on both groundwater and surface water. For the period of 2005 to 2013, surface water made up twenty-five percent (25%) of potable water demands, while groundwater was at seventy-five percent (75%) of demands. In 2014 the improvements for the SWTP were completed increasing production capacity from 15 MGD to 22.5 MGD. The benefits of these improvements are highlighted by the marked increase in production seen in 2014. The utilization of treated surface water has reduced groundwater pumping to a level that hasn't been seen since 1993.

Understanding the variability of water production over specific time intervals is critical to comprehending operating conditions and characteristics, and resources planning. Annual production records, like those shown on **Figure 4.2-2**, are vital to understanding production trends and can even reveal impacts from wet (lower water production) and dry (higher water production) periods of the yearly hydrologic cycle. As the time interval becomes smaller, transitioning from annual to monthly production, data reveals more information about the season variability of water production and the effectiveness of some water conservations measures. **Figure 5.1-1** shows the variability in monthly water production from the period from 2013 to 2015 and how the City's water conservation efforts have affected total production. First, the fact that the bell shape of this graphic generally resembles the evapotranspiration curve for grasses is not surprising given that single-family residences are the largest customer base and most of their water use is for landscaping. Second, the variability in monthly water production from one year to the next shows the effectiveness of the City's water conservation efforts. Lastly, any appreciable water conservation efforts are mainly achieved in a five (5) month period, May to September.

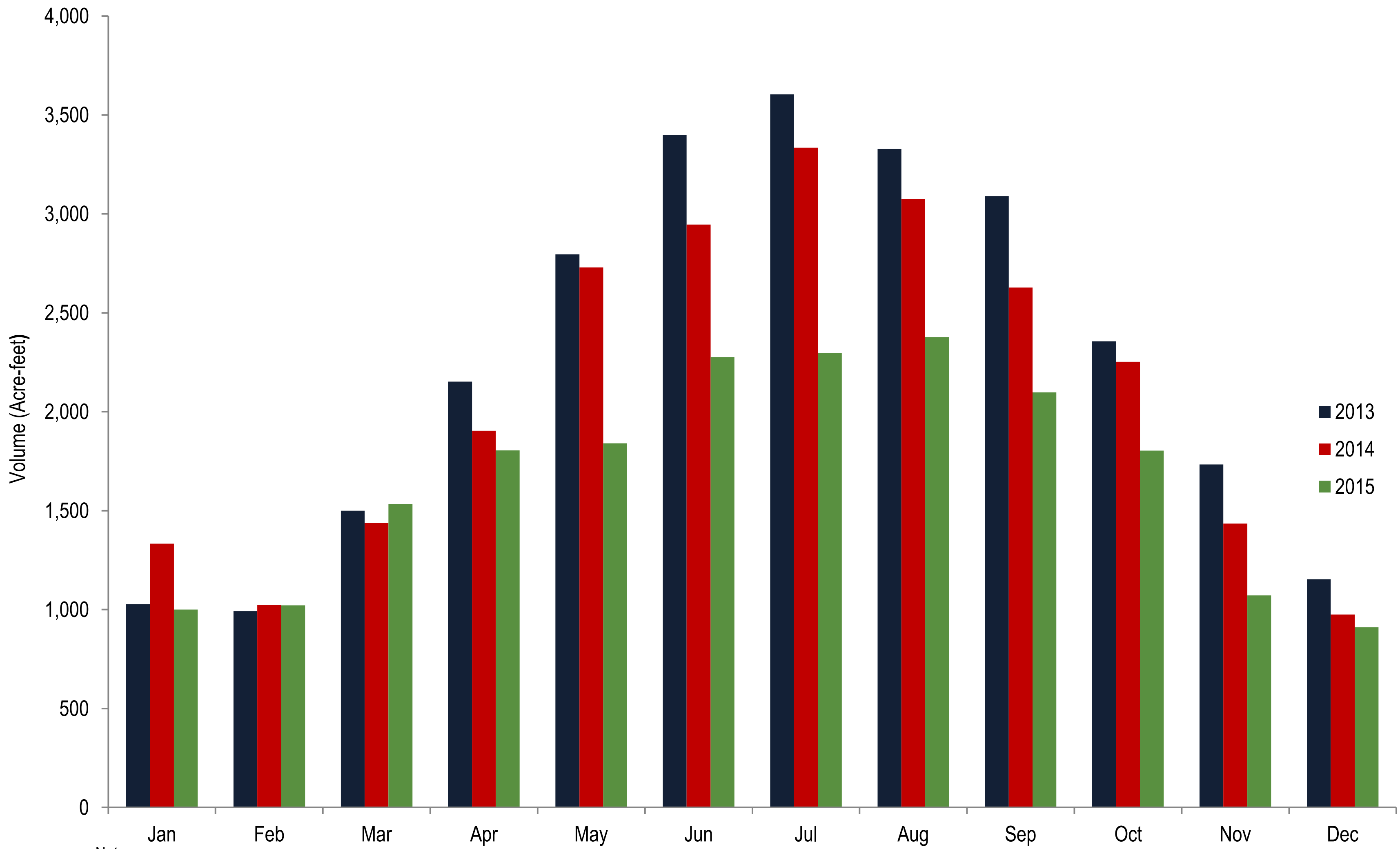
Table 5.1-1: Historic Water Production

Year	Wells (AF)	SWTP (AF)	Total (AF)	Percent From Wells	Percent From SWTP
2000	19,353	-	19,353	100%	0%
2001	20,194	-	20,194	100%	0%
2002	21,276	-	21,276	100%	0%
2003	22,599	-	22,599	100%	0%
2004	23,033	1,317	24,350	95%	5%
2005	18,239	5,894	24,134	76%	24%
2006	18,542	6,882	25,424	73%	27%
2007	22,476	4,947	27,423	82%	18%
2008	21,341	6,418	27,759	77%	23%
2009	19,086	7,092	26,178	73%	27%
2010	18,199	6,535	24,734	74%	26%
2011	16,541	7,390	23,932	69%	31%
2012	18,357	7,753	26,110	70%	30%
2013	20,159	6,962	27,121	74%	26%
2014	15,529	9,538	25,067	62%	38%
2015	12,189	7,839	20,028	61%	39%

Notes:
Data based on well production records obtained from the City of Clovis.

5.1.2 Historic Water Consumption

All water produced by the City is documented through metering. The City also meters their own uses including landscaping, parks, and City facilities. The City provides water to a County island, Tarpey Village; this area is partially unmetered including 405 unmetered connections and 949 metered connections as of October 2016. The City has a program in place to continue installing meters on a voluntary basis within the Tarpey Village area. It is anticipated this area will be entirely metered by 2025, in compliance with legislative requirements. Within the study area, in 2015, there were 33,002 active water services, of which 32,374 are metered and 628 are unmetered. Additionally, there are 454 fire service connections which are predominantly unmetered. Based on the City's summary reports filed with DWR the consumption for each year is shown and documented in **Table 5.1-2**. This consumption includes metered and Tarpey unmetered uses, but does not include unaccounted for water and losses.



Notes:
Values obtained from the City of Clovis.
Monthly values include Clovis groundwater production, surface water production, and Tarpey production.

Figure 5.1-1: Monthly Water Production for 2013 to 2015

Table 5.1-2: Historic Water Consumption

Year	Volume (AF)	Year	Volume (AF)
2000	18,379	2008	26,294
2001	18,905	2009	25,591
2002	20,097	2010	23,667
2003	21,845	2011	22,928
2004	24,503	2012	24,885
2005	23,560	2013	25,592
2006	25,045	2014	23,879
2007	27,129	2015	18,989

Note:
Data based on information provided by the City of Clovis
Table 5.1-1 indicates total water production for the water system.

5.1.3 Unaccounted For Water

Throughout the distribution system, losses of water may occur from hydrant flushing/testing, construction, firefighting, system leaks, main breaks, and unauthorized uses. This water loss is part of unaccounted for water (UAFW). Other potential sources of UAFW are meter or billing errors. All production water is fed to the water system and measured by water meters. Nearly all delivered water is also measured by meters and largely billed on a volumetric basis. The difference of total water produced and total water consumed yields the UAFW loss. The estimated unaccounted for water (UAFW) is documented in **Table 5.1-3**.

As is apparent in **Table 5.1-3**, UAFW ranges from about 300 to 1,500 AF. The lower values, those below 800 AF and the isolated negative value are believed to be the result of the reporting of manually read meters. The timing of individual meters does not correspond to the timing of the reading of production flowmeters. Individual meters are read bimonthly; approximately half of all meters are read monthly. Utilizing the remaining values, those above 800 AF, the average percentage of UAFW is 3.8%, which is reasonable and seems to indicate the system is well maintained. American Water Works Association (AWWA) Water Distribution Handbook notes UAFW averages about 10%. The 3.8% value will be applied to future projections when estimating demands.

Table 5.1-3: Historic Unaccounted for Water

Year	Total Production (AF)	Total Consumption (AF)	Unaccounted for Water (AF)	Unaccounted for Water² (%)
2000	19,353	18,379	974	5.0%
2001	20,194	18,905	1,289	6.4%
2002	21,276	20,097	1,179	5.5%
2003	22,599	21,845	754	3.3%
2004	24,350	24,503	-153	-
2005	24,134	23,560	573	2.4%
2006	25,424	25,045	378	1.5%
2007	27,423	27,129	294	1.1%
2008	27,759	26,294	1,465	5.3%
2009	26,178	25,591	587	2.2%
2010	24,734	23,667	1,066	4.3%
2011	23,932	22,928	1,004	4.2%
2012	26,110	24,885	1,225	4.7%
2013	27,121	25,592	1,529	5.6%
2014	25,067	23,879	1,188	4.7%
2015	20,028	18,989	1,039	5.2%
			Average Unaccounted for Water	**3.8%**

Notes:
Gross demand and consumption data per city report No. 38 to DWR.
Some years experienced late reporting for manual read meters and subsequently underreported water consumptions for that year and overreported water consumption for the following year. For these years, the percentage value was omitted.

5.2 Per Capita Based Water Demand Projections

5.2.1 Historic Per Capita Water Demands

Utilizing the estimated population values presented in Chapter3 and total production presented in section **5.1.1**, annual per capita water production values were calculated for the 2000 – 2015 period. Per capita water demands are shown in gallons per capita per day (gpcd) in **Table 5.2-1**. As is apparent in this table, per capita water production has varied from a low of 212 gpcd in the years 2011 and 2014 to a high of 260 gpcd in 2007. Since 2007, there has been a cyclic rise and fall in per capita water demands with the cycle now ending at the record low of 165 gpcd in 2015. The 10 year average for the period from 2000 to 2009 is 249 gpcd, and the 5 year average from 2010 to 2014 is 221 gpcd.

Table 5.2-1: Historic Per Capita Water Demands

Year	Distribution System Population	Gross Demand (MG)	Gross Per Capita Demand gpcd)
2000	72,473	6,306	238
2001	73,949	6,580	244
2002	76,471	6,933	248
2003	79,762	7,364	253
2004	84,068	7,935	259
2005	88,509	7,864	243
2006	92,196	8,284	246
2007	94,112	8,936	260
2008	96,441	9,045	257
2009	97,586	8,530	239
2010	99,519	8,060	222
2011	100,721	7,798	212
2012	102,372	8,508	228
2013	103,953	8,837	233
2014	105,796	8,168	212
2015	108,227	6,526	165

5.2.2 Adjustment for Conservation

The City has proactively encouraged its customers to use water wisely through measures such as residential plumbing retrofits, tiered water rates, customer and water system audits, washing machine rebate program, and public outreach programs. The effectiveness of these efforts is demonstrated by the general declining per capita values since 2008. A portion of the decline after 2008 is also associated to the economic downturn and the establishment of new higher water rates in 2010.

Recognizing the issue of dwindling water supplies for the State, legislator passed Senate Bill x7-7 (SBx7-7) the Water Conservation Act of 2009 which implemented mandatory statewide water conservation goals for urban water suppliers. The target of this legislation is to reduce urban per capita water use 20% by 2020. To aid in establishing water use reduction goals to meet the SBx7-7 requirements, the Department of Water Resources used the 2010 Urban Water Management Plans as a tool to assist urban water supplies in setting the appropriate interim 2015 and ultimate 2020 target per capita goals.

Since the time SBx7-7 was passed, the State has been in an historic drought, prompting additional conservation mandates from the Governor in the form of Executive Orders (EO) and emergency restrictions. The EO issued in April 2015 (EO B-29-15) and subsequent restrictions (SWRCB Resolution 2015-0015) mandated that the City of Clovis reduce their water production from 2013 levels by 36%. During the period the requirement was effective, June 015 through May 2016, the City's production declined by 31%.

The discussion of per capita values in this chapter is consistent with the UWMP requirements and those values reported in the 2015 UWMP Update.

In a manner consistent with the DWR guidelines for the 2010 UWMP, the average per capita value of 249 gpcd for the 10 year period from 2000 to 2009 was used and a uniform linear function was applied to attain 20% reduction by 2020. This results with an interim 2015 goal of 224 gpcd and an ultimate 2020 target of 199 gpcd. Based on this approach the City has already attained the 2015 Interim Target and should be able to meet the 2020 target. For the 5 years from 2010 to 2014, the average per capita consumption was 221 gpcd, with 2014 surpassing the interim 2015 target by dropping to 212 gpcd. The actual 2015 usage was singficantly below both the 2015 interim target and the 2020 target, but it is not sustainable without mandatory required reductions. Further reductions may be challenging as the single family residential per capita consumption for 2014 was 132 gpcd, which is down from the 164 gpcd seen in 2007 at the peak of City water use. This in itself is a 20% reduction, for the urban sector that comprises nearly 67% of all water consumption demands. The projected water demands shown in **Table 5.2-2** utilize both the 2015 Interim Target to estimate a high demand and the 2020 Target to estimate a low demand. Utilizing a range for the projected water demands allows the City to be conservative in planning for future supply and infrastructure needs while endeavoring to attain the SBx7-7 goal.

5.2.3 Per Capita Based Future Water Demand Projections

As was mentioned in the preceding section, the 2015 Interim Target of 224 gpcd will be used to project the high demands for future demands and the 2020 Target of 199 gpcd will be used to project the low demands for future projections. Utilizing the population projections discussed in Chapter 3 and the stated per capita values, projected water demands were developed and are presented in **Table 5.2-2**.

Table 5.2-2: Per Capita Based Water Demand Projections

Year	Service Population	2020 Ultimate Target (gpcd)	Low Demand Per Capita Projection (AF)[1]	2015 Interim Target (gpcd)	High Demand Per Capita Projection (AF)[1]
2015	108,227	199	24,100	224	27,200
2020	125,015	199	27,900	224	31,400
2025	141,467	199	31,500	224	35,500
2030	159,546	199	35,600	224	40,000
2035[2]	180,001	199	40,100	224	45,200
General Plan Update [3]	184,100	199	41,000	224	46,200
Full Buildout[4] (2083)	280,300	199	62,500	224	70,300

Notes:
Totals rounded to the nearest hundred AF
The 2035 population totals are based on percentage growth projections and the 2016 population.
The General Plan Update population totals include land within the 2035 General Plan Update.
The Full Buildout of the planning area is estimated in the year 2083. The population totals include buildout estimates for land within the 2035 General Plan boundary at the planned-for land use densities; however, the City is not planning for water supply distribution to the "Rural Residential" areas within the Between Canals and Southeast Corner villages. The population projection for Full Buildout has been reduced for this reason. There are 8,845 acres of Rural Residential in these two villages, assuming 0.5 DU/acre and 3.15 persons/DU, the population reduction is approximately 14,000.

5.3 Land Use Based Water Demand Projections

5.3.1 Develop Land Use Sector Unit Demand Factors

The process for developing Land Use Unit Demand Factors involves overlaying general plan land use designations of the service area with the water consumption data from the meter records. During the process any anomalies regarding data or land uses are identified and the data is refined, resulting in a tabulation of total water consumption for each type of projected land use in the study area.

5.3.2 Projected Land Use Sector Water Use Demand Factors

Utilizing the total acres within each land use category and the water demands associated with the parcels within the land use categories, Unit Demand Factors (UDF) were developed to aid in forecasting future water use demands. In this process, a statistical effort was undertaken using frequency and normal probability plots to identify outliers within the GIS data set. Outlier data was then examined to determine whether or not it should be utilized in the data set. In the case where data was found to be inconsistent and unexplainable, the metered flow and associated parcel acreage were removed from the data set. The refined data was then utilized to develop representative UDFs.

Water consumption data is also maintained by taking manual reads at various City facilities such as parks, public facilities, and right-of-way landscaping. The readily identifiable manually read data was added to the appropriate land use designations, and the UAFW was then proportionately distributed, based on metered usage per acre, to the land use designations. The resultant 2013 UDFs are presented in **Table 5.3-1** along with those developed as part of the 1999 Water Master Plan, for comparison.

Generally, the 2013 based UDFs remained the same or dropped from the UDFs developed for the 1999 WMP as a result of general conservation system-wide. Three land uses, mixed use village, office and general commercial, though had large increases over the earlier UDFs. The water usage data shows that, within the office and general commercial land use categories, more than 35% of the water usage was for landscaping. Additionally, it showed the top 20 water users in the commercial land use category accounted for nearly one-fourth of the water use within that sector, while the top 20 water users in the office land use category accounted for 86% of the total water use within that sector. Due to the increased amount of landscaping use and many high water users within both land use categories, the increase in UDFs is reasonable. The increase in mixed use village is considered reasonable due to the residential component of the mixed use, which is anticipated to have a density similar to high and very high density residential.

Table 5.3-1: Projected Land Use Unit Demand Factors

Land Use Category	2013 Unit Factors (AFY/acre)	1999 Unit Factors (AFY/acre)
Rural Residential	0.7	0.5
Very Low Density Residential	2.9	3.1
Low Density Residential	2.5	2.1
Medium Density Residential	2.2	2.1
Medium High Density Residential	3.3	3.4
High Density Residential	4.7	5.1
Very High Density Residential	7.3	-
Mixed Use Village	5.0	2.2
Mixed Use/Business Campus	5.0	-
Office	2.7	1.8
Industrial	1.0	1.0
Neighborhood Commercial	2.9	-
General Commercial	2.9	1.8
Open Space	1.5	-
Public Facilities	1.4	1.4
Parks	3.0	2.8
Schools	2.8	2.8
Water Basin	0.0	-

Notes:
The 1999 unit factors were developed as part of the Phase II water master plan update process.

5.3.3 Projected Land Use Based Water Demand by Villages

The land use acreages discussed in Chapter 3 are used with the UDFs presented in **Table 5.3-1** to calculate the project water demand shown **Table 5.3-2** and **Table 5.3-3**. These projections are presented by Village for consistency with preceding sections. These tables and subsequent tables separate the Villages into two subcategories: Urban Area and the remaining Villages. The "Urban Area" consists of Clovis, Northwest Village, Northeast Triangle, Loma Visa and Northeast Village and is the areas the City anticipates developing in the years covered by this Plan. The remaining Villages are shown for informational purposes and cover the remainder of the Sphere of Influence or General Plan boundaries.

Table 5.3-2: Projected Water Demands for the Sphere of Influence

Land Use Categories	Unit Demand Factor (AFY/acre)	Clovis	Northwest Village	Northeast Triangle	Loma Vista	Northeast Village	Urban Area Subtotal	Northern Rural	Northeast Corner	Between Canals	Southeast Corner	Totals	% of Total
Rural Residential	0.7	-	-	-	-	-	0	-	-	-	-	0	0%
VLD Residential	2.9	154	302	1,537	252	-	2,200	-	-	-	-	2,200	5%
LD Residential	2.5	11,215	603	690	3,005	265	15,800	-	-	-	-	15,800	35%
MD Residential	2.2	3,949	2,099	112	631	196	7,000	-	-	-	-	7,000	16%
MHD Residential	3.3	2,003	957	284	122	205	3,600	-	-	-	-	3,600	8%
HD Residential	4.7	1,081	367	113	259	273	2,100	-	-	-	-	2,100	5%
VHD Residential	7.3	-	-	-	73	80	200	-	-	-	-	200	<1%
Mixed Use Village	5.0	640	1,840	150	215	635	3,500	-	-	-	-	3,500	8%
Mixed Use/ Business Campus	5.0	380	115	715	280	1,800	3,300	-	-	-	-	3,300	7%
Office	2.7	775	-	-	-	-	800	-	-	-	-	800	2%
Industrial	1.0	548	-	-	-	-	500	-	-	-	-	500	1%
Neighborhood Commercial	2.9	55	41	-	26	-	100	-	-	-	-	100	<1%
General Commercial	2.9	2,384	-	-	70	-	2,500	-	-	-	-	2,500	5%
Open Space	1.5	80	-	15	132	81	300	-	-	-	-	300	1%
Public Facilities	1.4	225	13	6	101	-	300	-	-	-	-	300	1%
Parks	3.0	264	132	39	54	432	900	-	-	-	-	900	2%
Schools	2.8	1,450	-	45	428	73	2,000	-	-	-	-	2,000	4%
Water Basin	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Totals		**25,200**	**6,500**	**3,700**	**5,600**	**4,000**	**45,000**	**-**	**-**	**-**	**-**	**45,000**	**100%**

Notes:
Projected Water Demands are reported in acre-feet per year.
Water Demands for Rural Residential in Clovis has been converted to Low Density Residential to reflect a more realistic build-out scenario.
Totals rounded to nearest hundred.
Demands shown in the Northeast Village were proportionally removed from Clovis, Northwest Village and Loma Vista anticipating that growth in the Northeast Village will reduce growth in those villages.

Table 5.3-3: Projected Water Demands for the General Plan Boundary

Land Use Categories	Unit Demand Factor (AFY/acre)	Clovis	Northwest Village	Northeast Triangle	Loma Vista	Northeast Village	Urban Area Subtotal	Northern Rural	Northeast Corner	Between Canals	Southeast Corner	Totals	% of Total
Rural Residential	0.7	-	-	-	-	12	-	-	-	-	-	-	-
VLD Residential	2.9	154	302	1,537	252	-	2,200	-	-	-	-	2,200	3%
LD Residential	2.5	11,215	603	1,113	3,270	1,755	18,000	-	-	-	-	18,000	28%
MD Residential	2.2	3,949	2,099	332	827	2,446	9,700	-	-	-	-	9,700	15%
MHD Residential	3.3	2,003	957	363	327	2,112	5,800	-	-	-	-	5,800	9%
HD Residential	4.7	1,081	367	113	531	1,344	3,400	-	-	-	-	3,400	5%
VHD Residential	7.3	-	-	-	153	745	900	-	-	-	-	900	1%
Mixed Use Village	5.0	890	2,090	220	350	1,555	5,100	-	-	-	-	5,100	8%
Mixed Use/ Business Campus	5.0	1,380	315	715	880	1,800	5,100	-	-	-	-	5,100	8%
Office	2.7	775	-	-	-	-	800	-	-	-	-	800	1%
Industrial	1.0	548	-	-	-	-	500	-	-	-	-	500	1%
Neighborhood Commercial	2.9	55	41	-	26	-	100	-	-	-	-	100	<1%
General/Special Commercial	2.9	2,384	-	-	70	87	2,500	-	-	-	-	2,500	4%
Open Space	1.5	80	-	74	213	5,916	6,300	-	-	-	-	6,300	10%
Public Facilities	1.4	225	13	6	101	15	400	-	-	-	-	400	1%
Parks	3.0	480	240	105	162	618	1,600	-	-	-	-	1,600	2%
Schools	2.8	1,450	-	90	501	941	3,000	-	-	-	-	3,000	5%
Water Basin	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total		**26,700**	**7,000**	**4,700**	**7,700**	**19,300**	**65,400**	**-**	**-**	**-**	**-**	**65,400**	**100%**

Notes:
Projected Water Demands are reported in acre-feet per year.
Land use categories based on the 2014 General Plan.
Values in this table represent anticipated demands; actual usage may differ from these projected values.
Water Demands for Rural Residential in Between Canals and Southeast Corner have been deleted, as discussed in Table 5.2-2.
Water Demands for Rural Residential in Clovis has been converted to Low Density Residential to reflect a more realistic build-out scenario.
Totals rounded to nearest hundred.

5.4 Comparison of Per Capita and Land Use Based Water Demand

Water consumption projections have been developed based on both the 2020 Per Capita demand and the 2013 UDFs discussed in the previous sections. A comparison is provided below. For planning purpose the land based demands will continue to be used to estimate the water supply needs; this approach removes the uncertainty of population projection based water demands and allows the City to focus planning efforts in certain areas where the growth is expected based on the land use designations.

Table 5.4-1: Comparison of Water Demands Using Per Capita and Land Use Demand Factors

Year	Per Capita Demand (AFY)	Land Based Demand (AFY)
Sphere of Influence (2035)	41,000	45,000
General Plan at Buildout (2083)	62,500	65,400

Notes:
Totals rounded up to the nearest hundred AFY.

5.5 Peaking Factors

The development of peaking factors is a standard task for any approach to water planning. For general planning, typical factors are applied which have been taken from proximate systems. Whenever possible, it is most desirable to generate peaking factors based upon historic data for the actual system. For this plan, several different factors were developed using actual historic data. These included average day demand (ADD), maximum month (or peak month), maximum day (peak day or maximum day demand - MDD), and peak hour (PH). Each of these factors is critical to different aspects of the planning process and will be discussed briefly below. The multipliers (referred to as peaking factors) shown in the table relate the respective category to the average day demand.

Average Day Demand (ADD). This value is generated for both the system and each land use and is derived from the total annual demand expressed in terms of either a daily production value (gallons or ac-ft) or in terms of a rate that would be sustained for a 24 hour period. For the existing combined Clovis/Tarpey systems, estimated production would be 24.2 million gallons per day (16,800 gpm).

Maximum Month. This value consists of the highest month's production divided by the average monthly production. The values were checked by developing the same numbers from the meter records, which while not precise, did give some insight into the difference in seasonal peaking for individual land uses. The maximum month for 2013 was July, during which the combined Clovis/Tarpey systems produced 1,170 million gallons of water. The average monthly demand for 2013 was 740 MG, yielding a multiplier of 1.6 (1,170 MG / 740 MG).

Maximum Day Demand (MDD). Similar to the ADD, this value is expressed in terms of flow or total production and represents the highest rate or quantity of production over a 24 hour period. For this study, the maximum day was in July 2013 and had a demand of 40.9 MG. With an ADD of 24.2 MG, the MDD correlates to the ADD using a MDD factor of 1.7 (40.9 MG / 24.2 MG). This value is critical for planning because it is generally used along with fire flow requirements to establish the capacity of the water delivery system.

Peak Hour Demand (PHD). The peak hour is best developed from historic data recorded during peak use events. For a system as large as Clovis, the peak hour demand dictates the ultimate system capability with respect to water delivery capability. The peak hour was generated based upon knowledge of peak operating conditions obtained from discussion with the system operator and other data previously discussed. According to data provided, the highest peak hour demand occurred in July 2013 with a demand of approximately 50,400 GPM (72.5 MG). **Figure 5.5-1** is a diurnal curve showing the peak hour condition on this day. Using the ADD of 24.2 MG, the multiplier for PH analysis is 3.0. **Figure 5.5-2** shows a weekly pattern of water production and highlights the effect landscape water has on the demands. From the figure it is clear Monday is a reduced irrigation day and Friday is a non-irrigation day.

Table 5.5-1: System Wide Peaking Factor Comparison

Condition	2013	2014	2015
Average Day Demand			
Volume (MG)	24.2	22.4	17.9
Rate (gpm)	16,800	15,500	12,400
Maximum Month Demand			
Max Month (MG)	1,170	1,090	770
Average Month (MG)	740	680	540
Multiplier	1.6	1.6	1.4
Maximum Day Demand			
Volume (MG)	40.9	40.0	33.0
Multiplier	1.7	1.8	1.8
Peak Hour Demand			
Volume (MG)	72.5	62.2	48.0
Multiplier	3.0	2.8	2.7

Note:
Data based on information provided by the City of Clovis

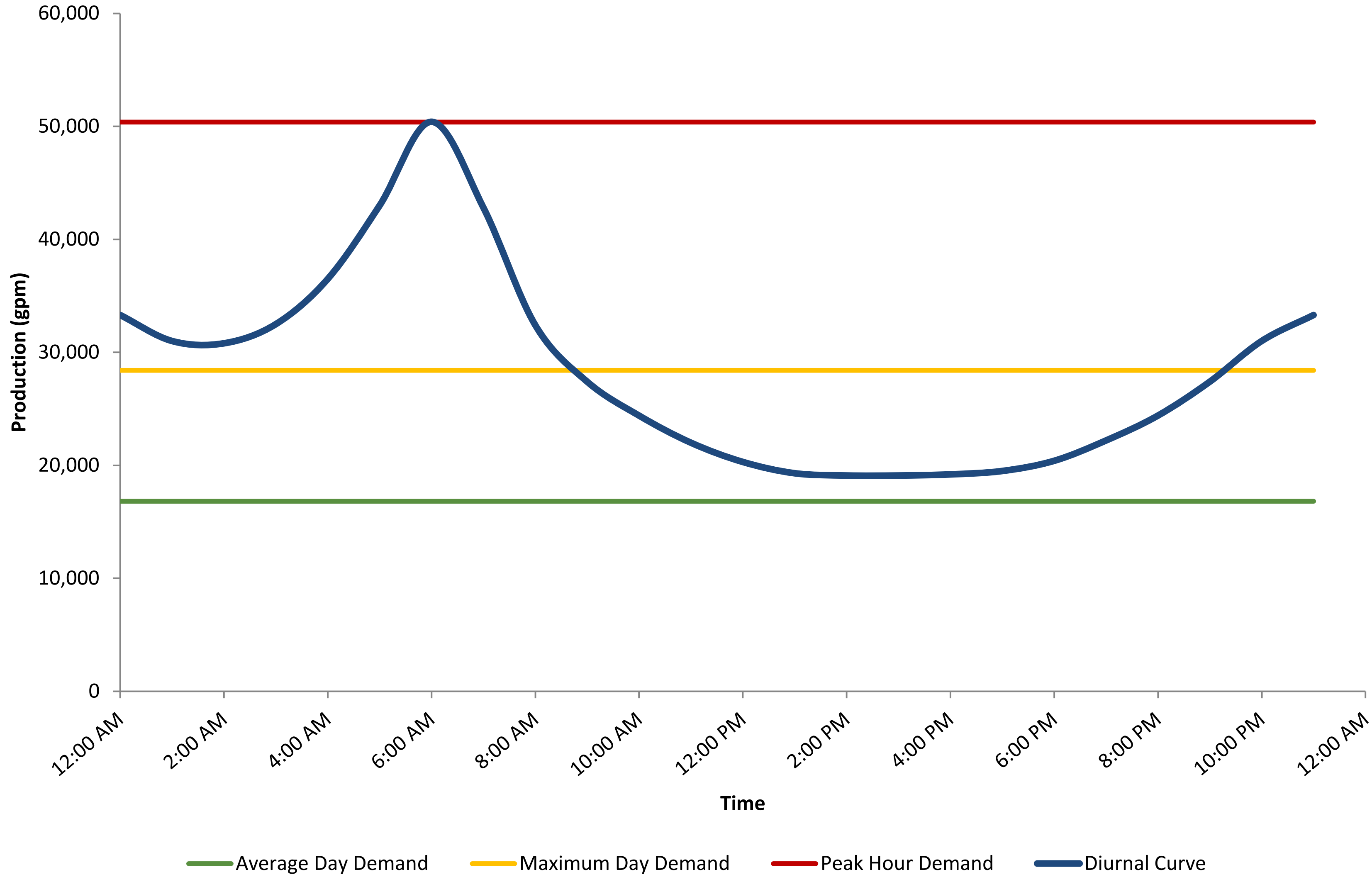


Figure 5.5-1: Daily Diurnal Curve

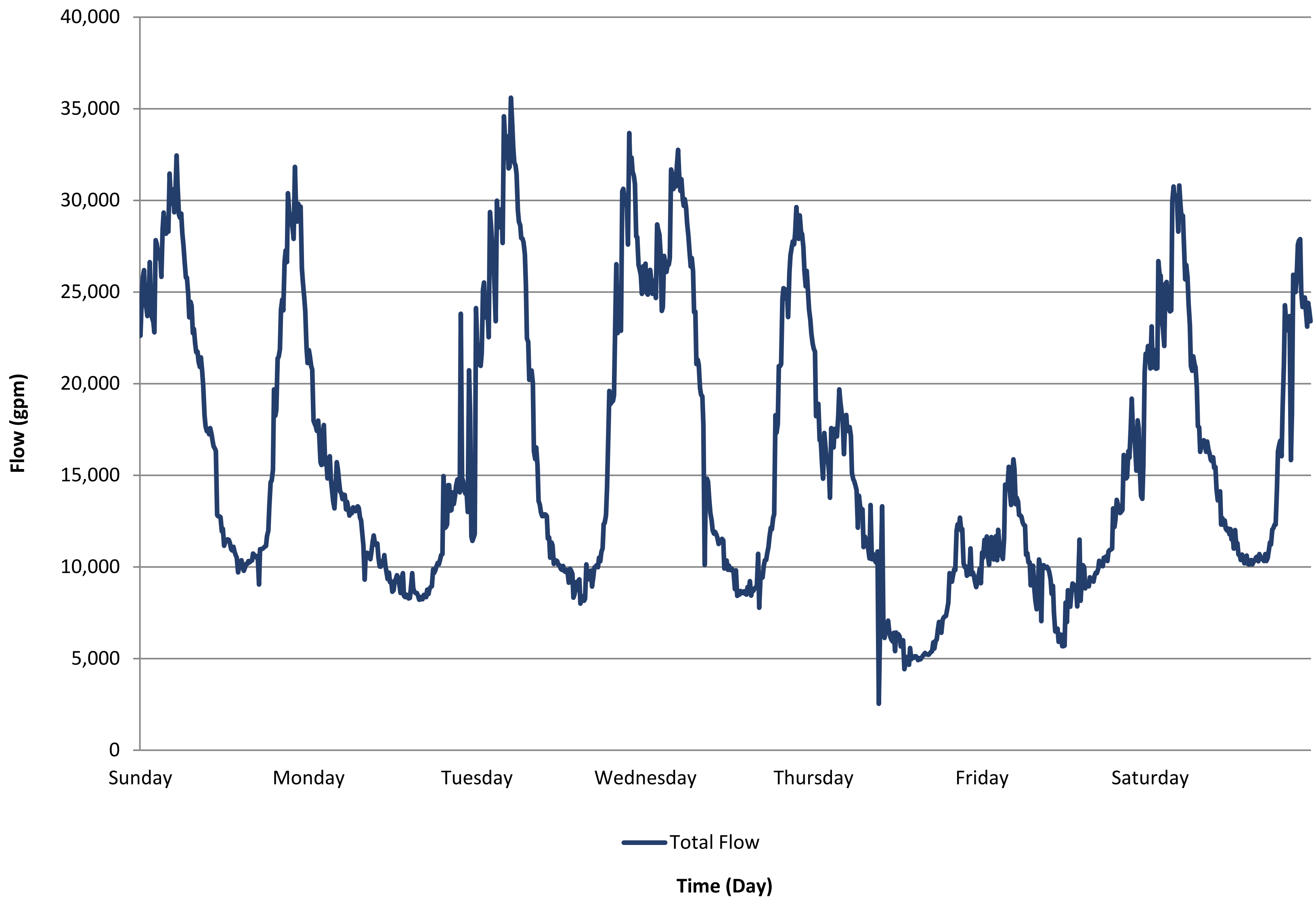


Figure 5.5-2: Weekly Diurnal Curve for Clovis Demand

5.6 Water Demand Projections

The estimated 2035 demand water demands are 41,000 and 45,000 based on population projections and land use demands, respectively. As discussed above, the land use based demand scenarios will be used for subsequent discussions in this report.

6 Groundwater

6.1 Introduction

The City of Clovis (City) water supply system has historically been entirely reliant upon water pumped from the aquifer beneath the City. Wells are spaced at intervals across the City and are connected to a distribution system. The pipes are sized for local distribution and have, in certain instances, presented some restrictions to cross-town water supply distribution. The transmission network consists primarily of 12-inch mains on a one-half mile grid with extensive looping. The wells are controlled by a telemetry system that controls pump operation as well as independent controls in case of remote computer failure. In addition to operating its own water system, the City of Clovis took over operation of the Tarpey Village water system (a Fresno County Island[10]) in 1989. The two systems are connected, but separated by valves. The Tarpey wells are located within a mile of each other along the Gould Canal in the southern portion of the City.

6.2 Groundwater Wells

As of 2016, there are 34 wells operating in the City of Clovis system. Of these 34 wells, there are two functioning for standby purposes only. There are also three additional wells operating within the Tarpey system. Typically, wells are put on standby status as a result of water quality problems and are maintained for emergency use. The production rate of the existing wells varies from approximately 300 gallons per minute (gpm) to approximately 2,200 gpm. The total production for the City of Clovis in the year 2014 was approximately 15,500 acre-feet. The Tarpey Village wells accounted for approximately 540 acre-feet of this total. **Figure 6.2-2** depicts the annual water production for both systems from 1984 to 2014. Existing wells are not evenly distributed across the service area, but rather generally located in the western one-half of the City of Clovis. In general, older wells are in the southwest quarter of the City and the newest wells are located to the northwest quarter of the City. The northern portion of the City of Clovis (north of Herndon Avenue), has experienced the highest growth in recent years, and has dramatically shifted the production and demand characteristics of the City's water system.

Previous studies of regional groundwater conditions in the Clovis area that provide information useful for this report include Page and LeBlanc (1969), John Carollo Engineers and Harshbarger & Associates (1969), County of Fresno, et al (1979 and 1986), Kenneth D. Schmidt and Associates (1991), and the Water Master Plan Phase I (1995) and Phase II (1999).

As part of previous evaluations of groundwater conditions in the service area, records had been obtained and evaluated through 1999. As part of this evaluation, records on regional groundwater conditions through 2014 were obtained and used. Historical information on City of Clovis wells, water-levels, production, pump tests, chemical quality, and intentional recharge practices were also obtained.

[10] A Fresno County Island is an area not annexed into the City limits but surrounded by the City on all sides. Tarpey Village is an area where the City also operates the water system built within the area.

Drilling of wells and test holes in the area north and east of Clovis has indicated that well yields in that part of the area are not as favorable as in much of the rest of the urban area to the south and southwest. There are problems that have been encountered in some locations including shallow bedrock and substantial thicknesses of clay strata. In addition, the area northeast of the Enterprise Canal is outside of the Fresno Irrigation District (FID), and canal water and/or distribution facilities for this water are not available. Concerns were expressed about the long-term adequacy of groundwater for urban development in parts of this area in the Northeast Fresno Groundwater Study (County of Fresno, 1972) and the 208 Water Management Plan (County of Fresno et al, 1979).

Primarily because of urban development, test holes and public-supply wells have been drilled, particularly in the area north of Shaw Avenue. These have provided a substantial amount of new information, particularly on subsurface geology, groundwater production capability, and groundwater quality. The rest of this discussion is organized in the following order: groundwater basin, subsurface geologic conditions, water levels, pumpage, aquifer characteristics, intentional recharge, and groundwater quality.

Figure 6.2-1 shows where wells exist in the area, including City of Clovis, Department of Water Resources and Fresno Irrigation District wells. Review of data from several of these wells lead to the conclusions discussed above. **Figure 6.2-2** illustrates the quantity of water that has been pumped by the City of Clovis historically.

Figure 6.2-1: Wells With and Without Hydrographs

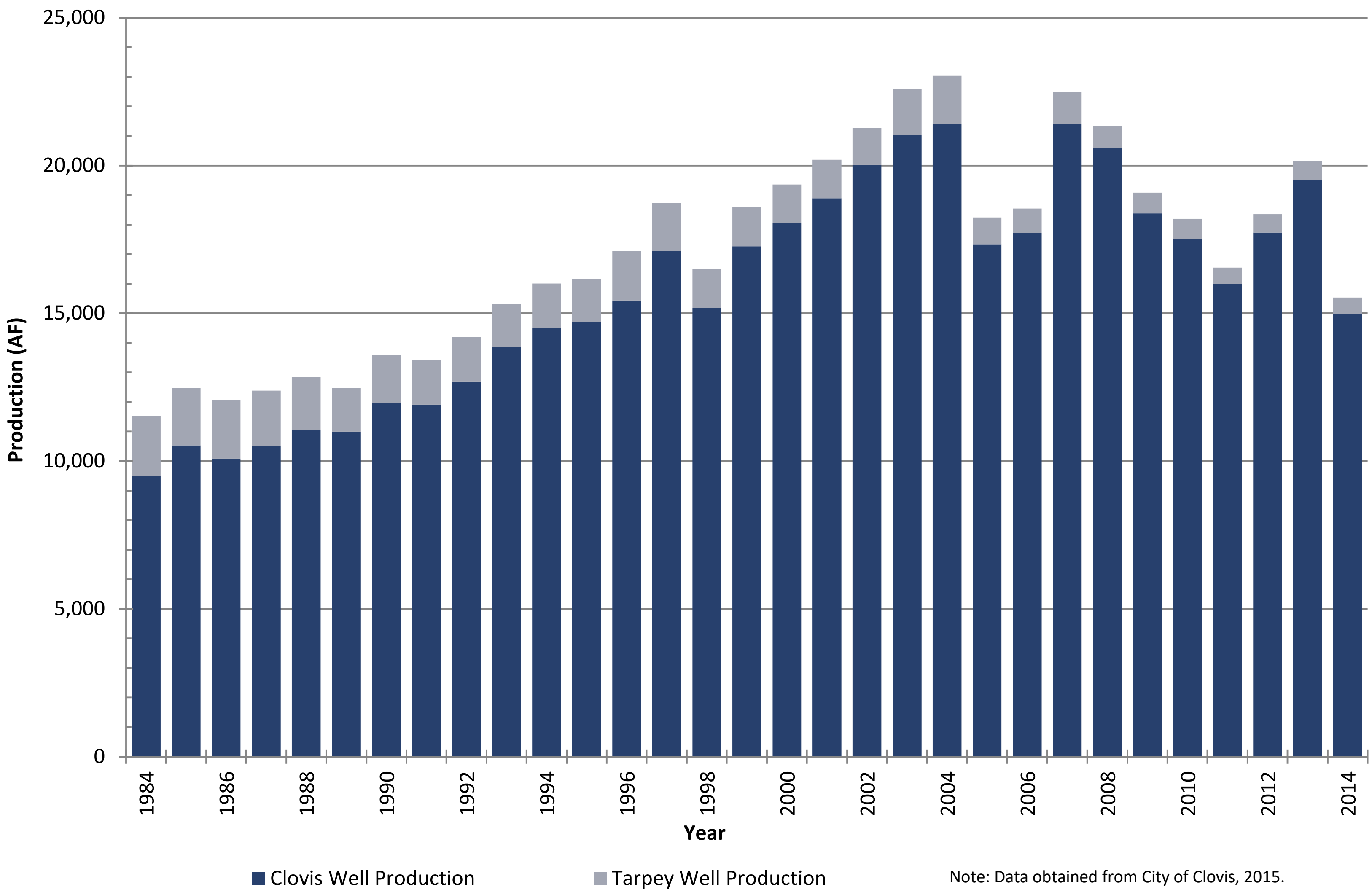


Figure 6.2-2: City of Clovis Historical Well Production

6.3 Groundwater Basin

Clovis is located in the Kings subbasin (see **Figure 6.3-1**), which is within the Tulare Lake Hydrogeologic Region. California Department of Water Resources (DWR) Bulletin 118-03 defines water balances for all groundwater basins and subbasins. The groundwater basin description for the Kings Subbasin was updated in 2006; a specific description from that bulletin states:

> The Kings Subbasin is bounded on the north by the San Joaquin River. The northwest corner of the subbasin is formed by the intersection of the east line of the Farmers Water District with the San Joaquin River. The west boundary of the Kings Subbasin is the eastern boundaries of the DeltaMendota and Westside Subbasins. The southern boundary runs easterly along the northern boundary of the Empire West Side Irrigation District, the southern fork of the Kings River, the southern boundary of Laguna Irrigation District, the northern boundary of the Kings County Water District, the southern boundaries of Consolidated and Alta Irrigation Districts, and the western boundary of Stone Corral Irrigation District. The eastern boundary of the subbasin is the alluvium-granitic rock interface of the Sierra Nevada foothills
>
> Groundwater flow is generally to the southwest. Two notable groundwater depressions exist. One is centered in Fresno-Clovis urban area. The other is centered approximately 20 miles southwest of Fresno (DWR 2000) in the Raisin City Water District.

The City of Clovis lies along the eastern margins of the subbasin and as such has experienced the dewatering of the upper portions of the aquifer caused by pumping throughout the entire basin.

The basin is defined by the State as being in a critical condition of overdraft with groundwater levels that have declined over time. The Environmental Protection Agency (EPA) has also identified this basin as a sole source aquifer since groundwater is the predominant supply to over fifty percent (50%) of the users within the Kings subbasin.

Figure 6.3-1: Kings Subbasin

6.4 Soils

Within the study area, soils are classified by three (3) associations. As noted in the Groundwater Recharge Investigation Report – Phase 1, the characteristics of the soils by type are:

Hanford - Tujunga association – This association included mainly Hanford and Tujunga series soils that are classified as deep, well drained to excessively drained, dominantly loamy sands to fine sandy loams. The soils are found on benches in river valleys and on flood plains of minor streams. They formed in recent alluvium derived mainly from granite rock. In addition to the Hanford and Tujunga series, minor series include Atwater, Delhi, Exeter, Greenfield and Visalia.

Greenfield - Atwater association – This association is classified as well-drained loamy sands and sandy loams that are moderately deep or deep to compact sandy material; partly wind modified. Soils in this association are found on young alluvial plains formed by deposits from small streams that drained the Sierra Nevada foothills. Others are on wind laid material blown from the sandier alluvial areas and dry channels by prevailing northeasterly winds. The Greenfield soils formed on stratified alluvial material, and the Atwater soils on the more uniformly sorted, wind laid material. In some places both soils are deep, but in large areas they are moderately deep over compacted weakly cemented, slowly permeable sandy material. Minor soils in this classification include Delhi, Hanford, and Tujunga.

San Joaquin - Exeter - Ramona association – This association is classified as Sandy loams to loams that are shallow or moderately deep to hardpan and deep sandy loams and loams. Most soils of this association have a hardpan that is cemented with iron silica. The hardpan occurs at depths of one to four feet is relatively impermeable to roots and water. The Ramona series have moderately restrictive subsoil, but lack the hardpan common to the other series. Minor soils included in this association and found in the study area include Cometa and Madera.

The soils in the northern part of the study area are predominantly loamy soils. These soils are identified as the San Joaquin, Ramona, and Holland soil series are underlain by hardpan. They have low to moderately low permeabilities, while their water holding capacities range from low to high. The soil is poorly drained and forms areas of gently sloping terrain to nearly level land surface. In its virgin condition, the San Joaquin sandy loam was treeless, except for a scattering of growth along streams; the only vegetation consisted of grasses and wild oats. For support of irrigated agriculture, the soil requires intensive management and can be used for a variety of crops including figs, olives, vineyards, deciduous fruits, and citrus. Irrigated agriculture may require breaking up the hardpan by blasting or ripping. Ripping is the most common method, as it improves the internal drainage and deepens the soil.

Soils that are more centered in the City of Clovis urban area consist of Madera Sandy Loams. The Madera series consists of well drained soils that have dense fine textured subsoil, and are moderately deep with hardpan at depth. There are many areas where the hardpan occurs at a depth greater than 6 feet. The largest continuous body of this soil lies upon the sloping plains northwest and eastward from the vicinity of the City of Fresno. It occurs on terraces and in other areas of old alluvium, such as older and high alluvial fans. An excerpt from the 1912 soil survey states:

> Prior to the construction of the present dike systems, a number of foothill streams, including Fancher, Redbank, and Dry Creek, overflowed or discharged their water on areas of this type.

The surface soil of the Madera and Fresno sands are medium to rather course in texture, grayish brown or light to brown in color. They have low organic matter content. This type of soil occupies the gently sloping or undulating, valley plains, occurring as low, broad alluvial fans or delta-like areas. Channels and depressions have been either wholly or partially obliterated by blowing in of sand and a number of the smaller circular depressions seemed to have been caused by the same process. In its natural condition, the Fresno sand is of very loose structure and when water is applied for the first time the soil undergoes considerable settling, with the result that the surface often sinks a foot or more in patches a few to several feet in diameter. Owing to the method of deposition, these soils generally occur as elongated bodies with a general northeasterly to southwesterly trend in the valley plains. The soils merge gradually into adjacent soil types, and it is commonly difficult to define specific soil boundary lines. These soil types are free from alkali and drainage conditions are always good and sometimes excessive. **Figure 6.4-1**, displays a generalized soil map for the study area with information obtained from the Natural Resources Conservation Service (NRCS).

As the soil conditions relate to intentional recharge efforts, the Hanford-Tujunga association would be the most suited for this application. As shown in **Figure 6.4-1**, these favorable soils conditions exist primarily in the central-west portion of the study boundary, with several veins stretching to the east. Notably, the Hanford-Tujunga association does not exist in the northeast or eastern portions of the study area, making these areas less favorable for intentional recharge than the southwest or west areas.

Figure 6.4-1: NRCS Soil Survey

6.5 Subsurface Geologic Conditions

Page and LeBlanc (1969) provided the regional subsurface geologic framework for the Fresno-Clovis area as of that time. Information from drillers logs, electric logs, and geologic logs can be used to provide more detail on subsurface geologic conditions in specific parts of the area. Prior to the 1969 investigation of the urban area by John Carollo Engineers and Harshbarger and Associates, no electric logs were known to be available for water wells in the area. The drillers' logs were available, and wells at that time were generally shallow (usually less than 300 feet deep).

Commencing in the late 1970s, a number of geologic and electric logs were obtained from test holes that were drilled in the City of Clovis and adjacent areas in the City of Fresno. In addition, it has become standard practice in the past decade to have electric logs performed for new public-supply wells in the Fresno-Clovis urban area.

Figure 6.5-1 shows the locations of test holes and wells in and near the urban area for which electric logs and geologic logs are available. Presently available data now extend to a depth of about 500 to 600 feet throughout much of the Clovis urban area. However, little data is available outside of the urban area. Drillers' logs are available for the rural area, but most wells are less than 200 feet deep.

The alluvial deposits in the area have been subdivided into several types, based primarily on the predominant particle size and interpretation of the electric logs. One unit comprises deposits primarily coarser than sand, usually cobbles, gravel, and sometimes boulders. Deposits of this type tend to have the highest resistivities on the electric logs and are generally the most permeable of the deposits, except when inter-mixed with clay. Electrical resistivity, in areas where the groundwater salinity is low, is primarily a function of the permeability of the subsurface deposits. A second type comprises deposits that are primarily sand in texture. Deposits of this type tend to have the next highest resistivities on the electric logs, and are also generally highly permeable. These two coarse-grained strata comprise the major water-producing deposits of the Clovis area. A third type comprises deposits that are primarily clay. Deposits of this type tend to have the lowest resistivities on the electric logs and generally have the lowest permeability of all the deposits. If these strata are sufficiently thick, then they may act as a confining bed, to separate groundwater in the overlying and underlying coarse-grained deposits. The fourth type comprises fine-grained deposits of an intermediate texture between sand and clay. Included in this type are silt, sandy clay, clayey sand, and silty clay deposits. These deposits generally have resistivities intermediate between sand and clay. Deposits of this type are believed to have a low to moderate permeability, can contribute some water to wells, and probably do not act as significant confining beds. All of the alluvial deposits vary in thickness and extent, and sometimes individual units cannot be correlated for great distances laterally. However, there is overwhelming evidence that the course-grained water-producing strata are well connected hydraulically.

Several subsurface geologic cross-sections were developed for the study area. These cross sections include the cross-sections developed in the Groundwater Recharge Investigation Report – Phase 1 and were expanded to more thoroughly cover the study area. **Figure 6.5-1** shows the locations of the geologic cross sections. **Figure 6.5-2** through **Figure 6.5-11** depicts the subsurface cross-sections.

Figure 6.5-1: Location of Wells with Geologic Cross Sections and Electric Logs

Cross-section for A-A' extends from the southwest to northeast. The southwest end of this section is near the Former Lind Avenue City Corporation Yard (Well 4-AA), and the northeast end is near Tollhouse Road and Copper Avenue. The area of shallow bedrock near Tollhouse Road and Herndon Canal is shown, as is the thickening of the alluvium to the southwest. This section illustrates the transition from an area of limited groundwater production due to shallow bedrock in the northeast, to an area of more favorable groundwater production due to the presence of a thick section of highly permeable alluvium in the southwest.

Cross-section B-B' extends through Clovis, from Well No. 25 (Nees and Minnewawa Avenues) southeast to City Well No. 20 (Barstow and Armstrong Avenues), thence south to test hole T13S/R21E-22D (near Ashlan and Fowler Avenues). The northernmost four wells along this section are in the Herndon-Shepherd Plan Area, and the southern three are in or near the East Clovis area. The three southernmost holes or wells ranged from 514 to 855 feet in depth. Five test holes or wells along this cross section encountered bedrock (metamorphic rocks), at depths ranging from about 360 to 440 feet. Depth to bedrock increases to the southeast along this section. Coarse-grained deposits of the older alluvium generally thicken to the southeast along this section. At City Well No. 25 these deposits are only about 110 feet thick, at Test Well 89-B, they are about 170 feet thick, and at City Well No. 16, they are about 250 feet thick. The under-lying continental deposits are predominantly fine-grained, although there are some relatively thin interbedded coarse-grained strata that are also present.

Previously, three subsurface cross-sections were developed farther south and east from the above location. These cross-sections were primarily in the Herndon- Shepherd Plan area. Section C-C' extended from the northwest to the southeast through the area. Two sections (D-D' and E-E') were developed along and near Dry Creek, between Teague and Bullard Avenues. Generally favorable conditions for intentional recharge were indicated along much of Dry Creek, particularly in the area south of Alluvial Avenue.

For this investigation, cross section D-D' was extended about one mile to the northeast, along Dry Creek to near Armstrong and Shepherd Avenues. Although some of this area is north of the Enterprise Canal, it may be possible to recharge in this area from Dry Creek releases or other means. Also, a new subsurface cross section (F-F') was prepared, generally extending along the Enterprise Canal.

Shallow bedrock is present in this area, and was encountered by some wells along both sections. Extended section D-D' indicates a predominance of fine- grained deposits with the uppermost 50 feet or so near the Enterprise Canal. However, north of Shepherd Avenue, coarse-grained deposits are predominant above the hard rock. Near Armstrong and Shepherd, the top of the weathered zone is only about 70 feet deep. The top of the weathered zone deepens to a depth of about 150 feet near the Enterprise Canal.

Along Section D-D', subsurface conditions favorable for intentional recharge are indicated south of Alluvial Avenue, between Minnewawa and Dry Creek, just north of Nees Avenue and near Teague Avenue. Another favorable area appears to be north of Shepherd Avenue along the Dry Creek.

Cross-section F-F' generally shows a predominance of fine-grained deposits above a depth of about 50 feet. Thus this area is considered unsuitable for intentional recharge by basins.

Cross-section G-G' extends from Willow Avenue near Perrin Avenue to Nees Avenue near Armstrong Avenue. Coarse-grained deposits can generally be found between Willow and Minnewawa Avenues; however the conditions quickly become predominantly fine-grained deposits in the easterly direction.

Along cross-section H-H’, the surface structure is primarily fine-grained deposits, but there are interbedded layers of fine- and coarse-grained deposits. The boring on the north side of the Enterprise Canal is predominantly cross-grained deposits to a depth of 60 feet. The site previously identified as B-3 in the Groundwater Recharge Investigation (P&P 1997) is located along Freeway 168 near Minnewawa Avenue. Cross sections available indicate that this area is favorable for intentional recharge. Soil borings were recommended and completed as discussed later in this report.

Cross-section I-I’ extends from near International and Willow Avenues in a southeast direction to Perrin and Minnewawa Avenues. Sand is predominant in the upper strata near International Avenue and extending southeast to the Enterprise Canal where it begins to incorporate sandy clay and then transitions entirely to clay for the remainder of the cross-section. The upper portion of this cross-section seems generally favorable for intentional recharge; however, information on the water supply wells in the area indicate it is difficult to recover the recharge water, thus the area is not suggested for intentional recharge.

Along cross-section J-J’ begins at the same point as cross-section G-G’, along Willow Avenue between Behymer and Perrin Avenues and continues northeast to International Avenue near Minnewawa Avenue. Sand and coarse-grained deposits can be found on the southwest portion of the cross-section; however, the conditions become more clayey in the easterly direction.

The California Department of Transportation has completed borings along the Freeway 168 alignment at Palo Alto and Sierra Avenues. These borings are generally from 15 to 25 feet deep.

For the Palo Alto Avenue borings, one had cross-grained deposits for the total depth of 21 feet. The other three western-most borings had fine-grained deposits from surface to about 10 feet, and generally indicated unfavorable conditions for intentional recharge. Two of the soil borings at Sierra Avenue indicated a predominance of cross-grained deposits to depths ranging from about 15 to 24 feet. Of the southerly two borings, about three feet of clayey-sand were present at depths of 7 to 8 feet. The borings along Sierra Avenue generally indicated favorable conditions for intentional recharge, but deeper exploration is necessary.

In summary, subsurface geologic conditions are more favorable for groundwater development in the southwesterly part of the study area, and less favorable to the northeast. Alluvial deposits conducive to development of large capacity wells thin to the northeast. Besides shallow bedrock beneath the northeast part of the area, other constraints to development of public supply wells in eastern Clovis are a local siltstone unit which limits well production capacity and reduced (blue-green) deposits, which can be associated with groundwater quality problems. Deeper subsurface geologic conditions are poorly known beneath the eastern part of the study area due to a lack of deep test holes or wells.

Figure 6.5-2: Cross-Section A-A'

Figure 6.5-3: Cross-Section B-B'

Figure 6.5-4: Cross-Section C-C'

Figure 6.5-5: Cross-Section D-D'

Figure 6.5-6: Cross-Section E-E’

Figure 6.5-7: Cross-Section F-F'

Figure 6.5-8: Cross-Section G-G'

Figure 6.5-9: Cross-Section H-H'

Figure 6.5-10: Cross-Section I-I'

Figure 6.5-11: Cross-Section J-J'

6.6 Water Levels

Figure 6.6-1 shows water-level elevations for Spring 2014. Water-level elevations ranged from more than 430 feet above mean sea level near the Friant-Kern Canal south of Tollhouse Road to approximately 180 feet in the area near Herndon Avenue between Willow and Peach Avenues; a significant cone of depression-was indicated in this area. A recharge cone was indicated between Ashlan and Dakota Avenues along Willow Avenue. This second recharge cone is just southwest of the City border. The direction of groundwater flow in the area between Herndon and Shepherd Avenues near Willow Avenue was to the southwest and into the City of Fresno. Beneath most of the City of Fresno North Growth Area (west of Willow Avenue and north of Herndon Avenue), the direction of groundwater flow in recent years has been to the south. The direction of groundwater flow near Ashlan Avenue and east of Clovis Avenue was to the west, parallel to the boundary between the City of Clovis and the City of Fresno. Along Willow Avenue between Shaw and Ashlan Avenues, there was northwesterly groundwater flow from the City of Clovis to the City of Fresno.

The direction of groundwater flow which would be perpendicular to the contour lines indicate the importance of recharge from Big Dry Creek and the associated reservoir, which appears to affect most of the groundwater beneath the City of Clovis north of Herndon Avenue, and in particular the Herndon-Shepherd Plan Area. Groundwater south of Herndon Avenue is indicated to be recharged by seepage from Pup Creek, Dog Creek, and Redbank Creek, including the Redbank Creek Reservoir. Deep percolation from lands irrigated with canal water, canal seepage, and intentional recharge basins comprise the rest of the recharge.

Figure 6.6-1: Elevation of Water in Wells Spring 2014

6.7 Depth to Water

Figure 6.7-1 shows depth to water for Spring 2014. The water-level measurements used for this map are primarily for water supply wells, and may not reflect the shallowest groundwater levels. The overall trend shows deeper water levels to the west. Depth to water ranged from less than 30 feet near Redbank Creek and East Ashlan Avenue to more than 180 feet in the depression cone centered near Herndon and Peach Avenues. East of Locan Avenue, depth to water was generally less than 80 feet. Along Willow Avenue, north of Shaw Avenue, depth to water ranged from about 150 to almost 180 feet.

Figure 6.7-1: Depth to Water in Wells Spring 2014

6.8 Water Level Trends

Water-level hydrographs were prepared for 15 City of Clovis wells spread throughout the study area. The records of these wells extend as far back as 1973. Average rates of water-level decline for these wells ranged from 1.1 to 3.7 feet per year. The average water-level decline was 2.3 feet per year. The lowest rates of decline (averaging about one foot per year) were for City Wells 8A and 30, located near Herndon and Villa Avenues and Nees and Sunnyside Avenues, respectively. The greatest rates of decline (3.0 feet per year or more) were for wells T-8 and 25. Water-level hydrographs for several wells (No. 5, 8A, 21, 22, 23, 34, 41) indicated lesser rates of decline after about 2005. This is believed to be due to less pumpage when the SWTP went online and due to conservation during the drought.

Hydrographs for City wells 4AA, 5, 8A, 17, 21 thru 25, 29, 30, 34, 41 and T-8 are depicted in **Figures 6.8-1 through 6.8-10**, respectively. Data from these hydrographs seem to indicate that water levels are stabilizing within the City boundary in recent years. A review of static water elevations at select wells show that from 2007-2014 that despite seasonal level fluctuations, the overall water elevation trend is relatively flat. As seen in the hydrograph from Well 31 the water levels show a rise over the time period. Based on the data shown in the hydrographs for wells 22, 23 and 30, the City's efforts to recharge water into the ground are having positive effects.

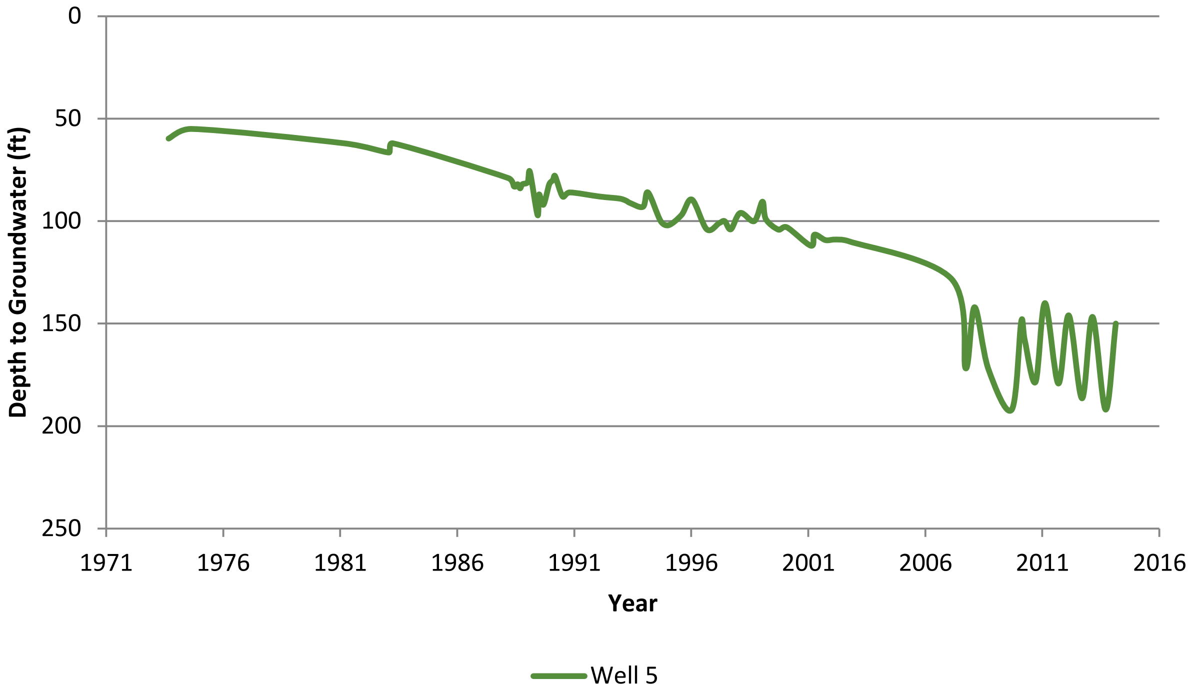


Figure 6.8-1: Well 5A Hydrograph

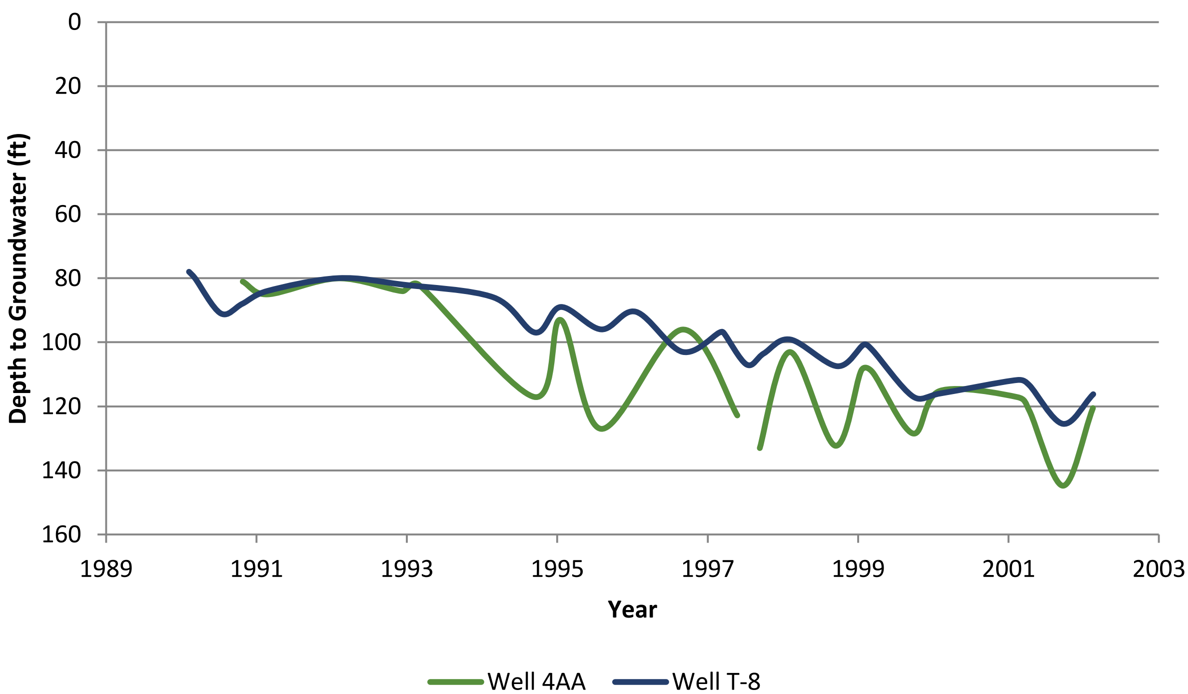


Figure 6.8-2: Wells 4AA and T-8 Hydrograph

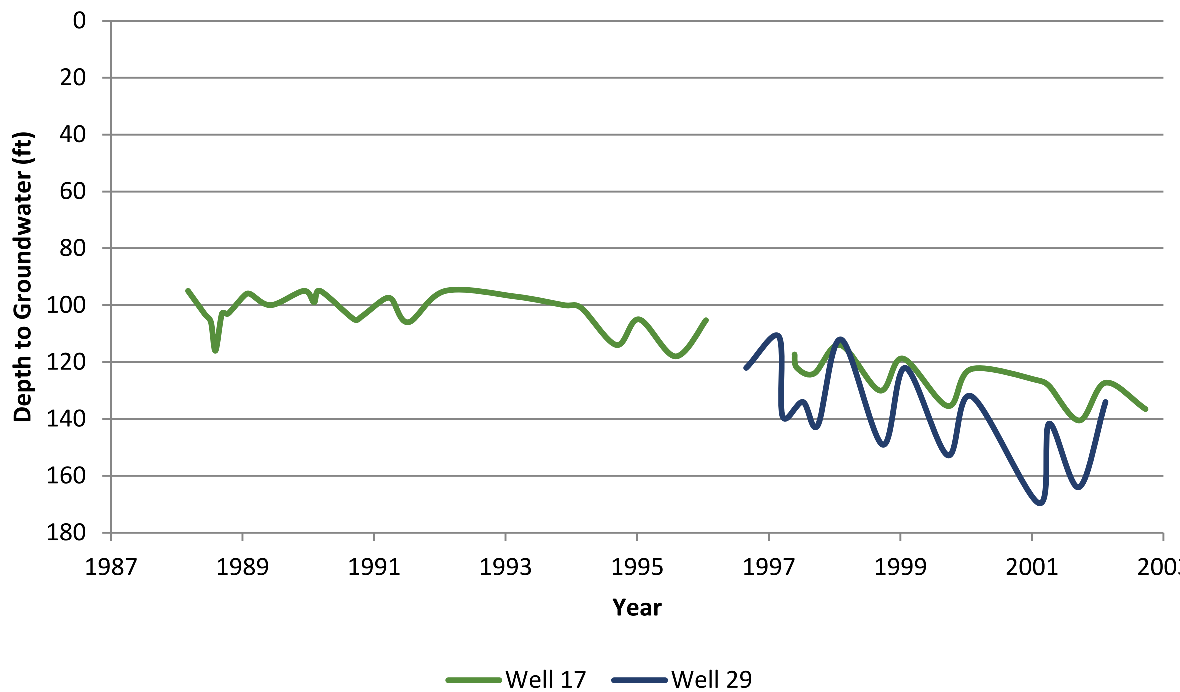


Figure 6.8-3: Wells 17 and 29 Hydrograph

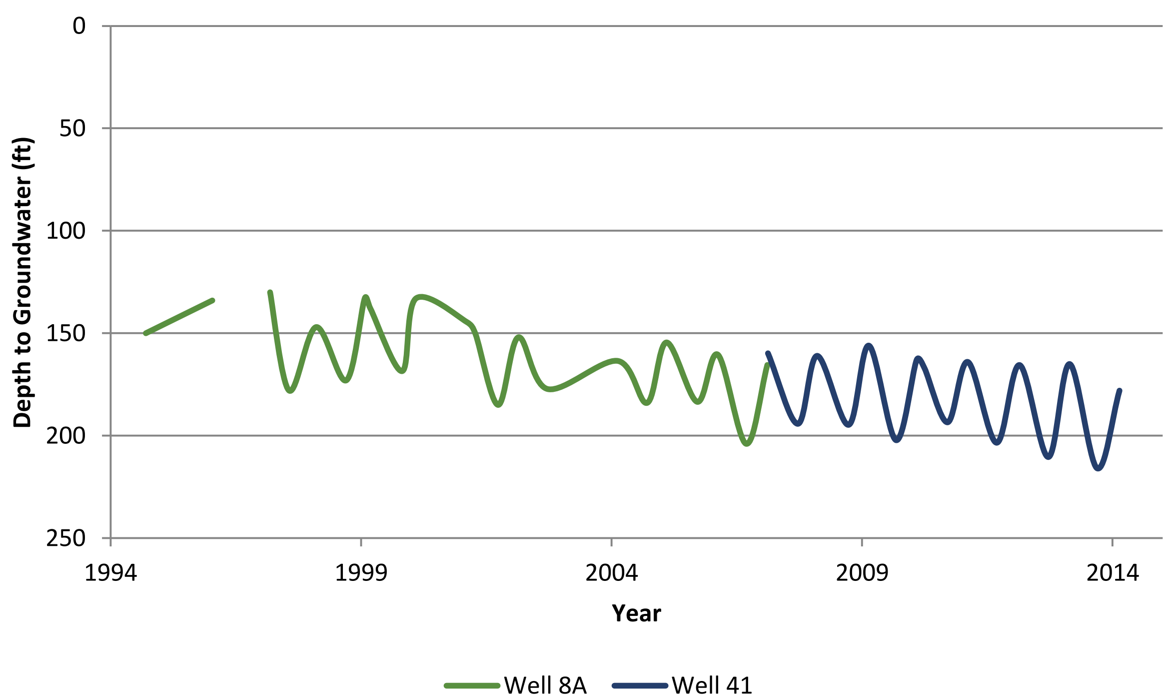


Figure 6.8-4: Wells 8A and 41 Hydrograph

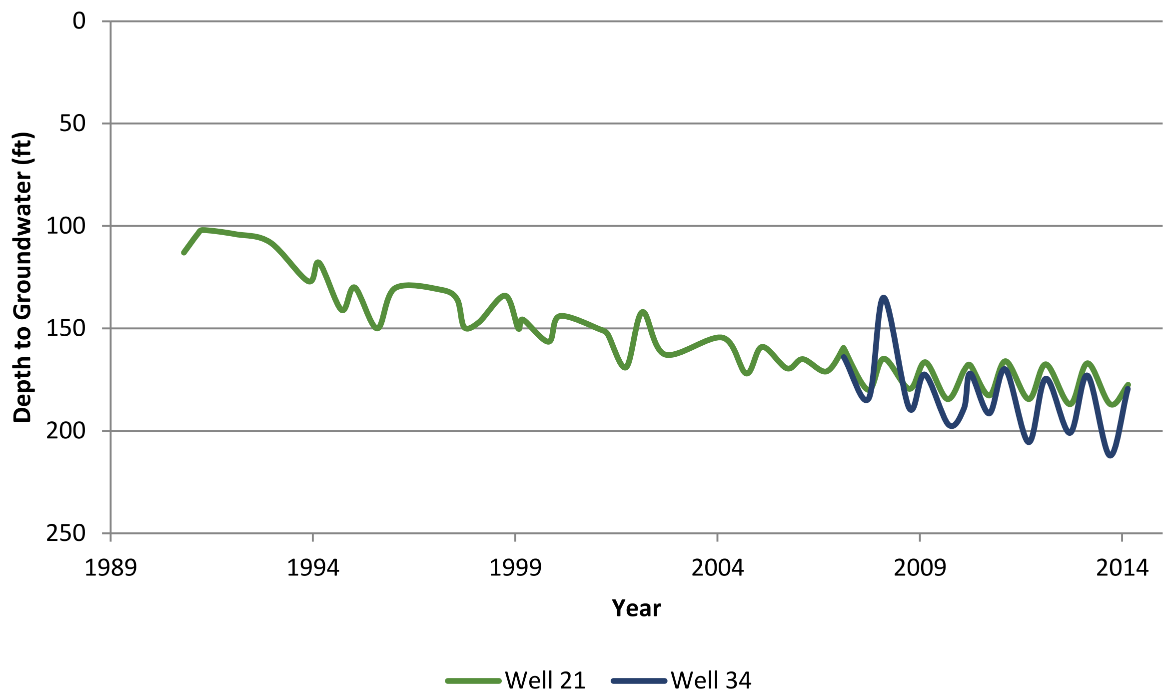


Figure 6.8-5: Wells 21 and 34 Hydrograph

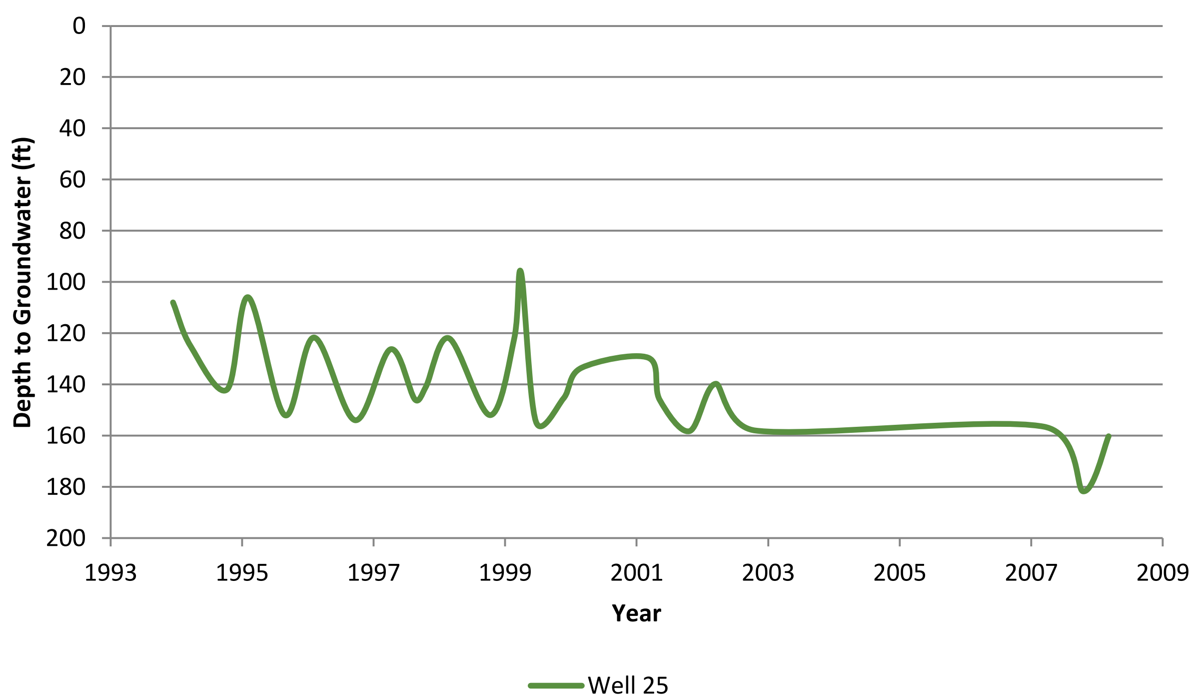


Figure 6.8-6: Well 25 Hydrograph

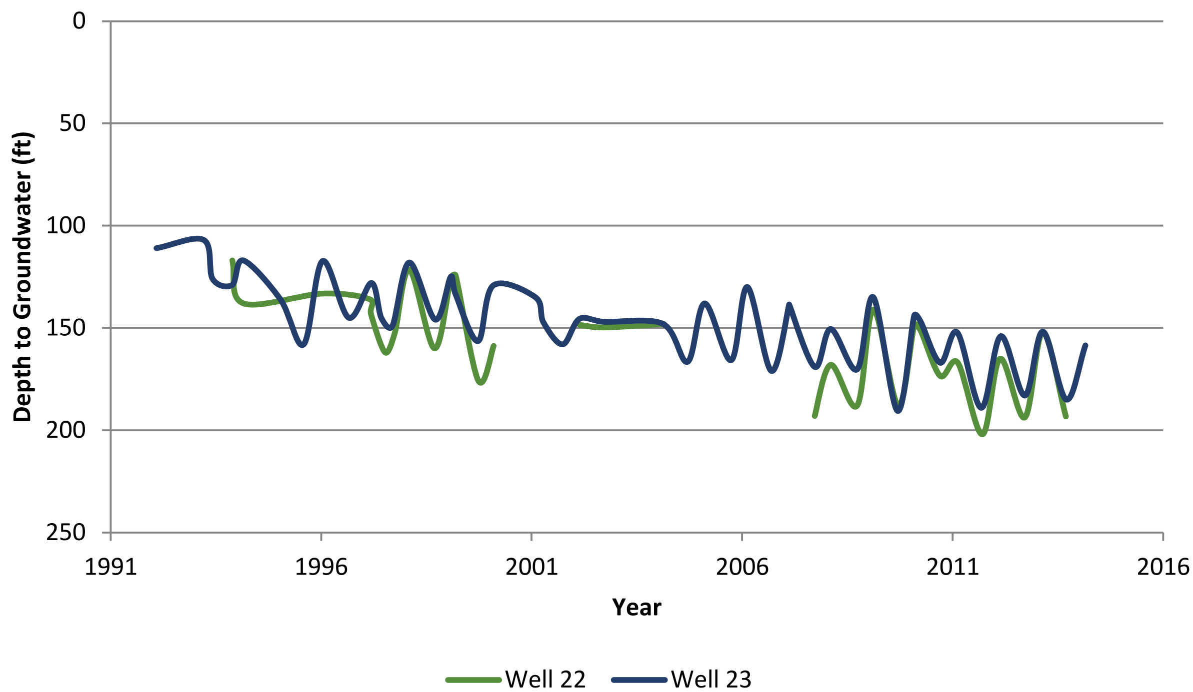


Figure 6.8-7: Wells 22 and 23 Hydrograph

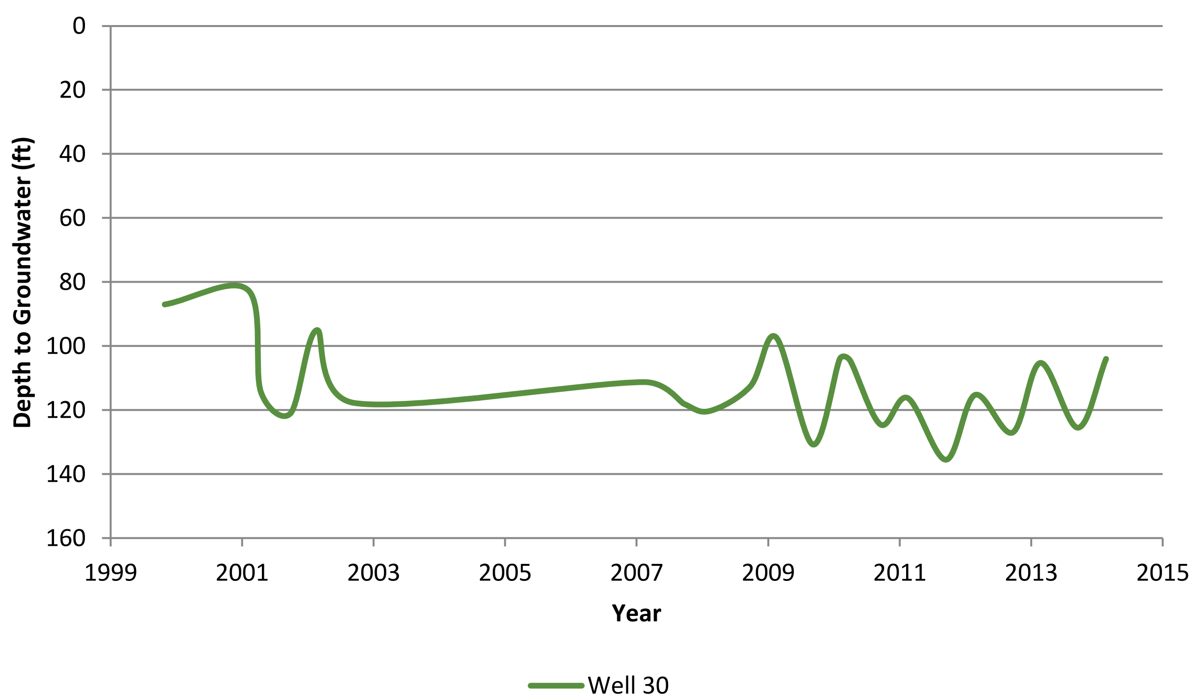


Figure 6.8-8: Well 30 Hydrograph

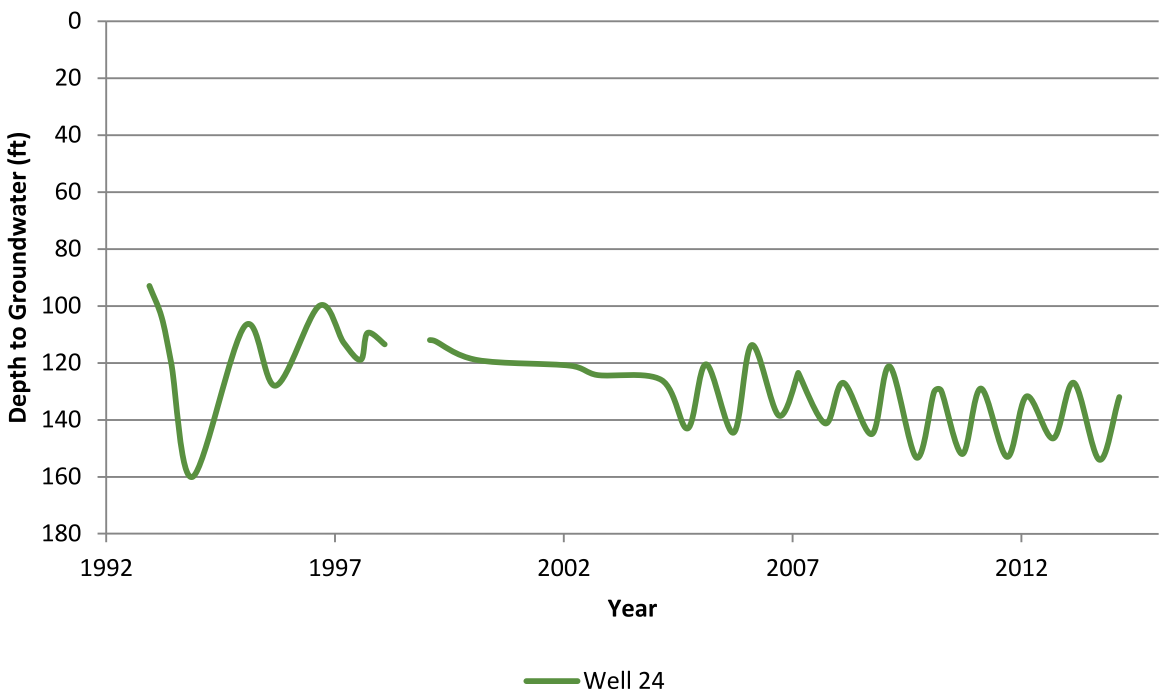


Figure 6.8-9: Well 24 Hydrograph

6.9 Wells Production and Aquifer Characteristics

Table 6.9-1 summarizes the most recent pump test data available for the City of Clovis wells. Pumping rates for individual City wells in recent years have ranged from about 200 gpm to almost 1,500 gpm. However, the pumping rates for most wells have ranged from about 600 to 1,300 gpm. The specific capacity is the pumping rate divided by the drawdown. The specific capacity values cited were based primarily on short-term pump tests, where the true static level was often not measured; therefore, the values reported usually have a smaller drawdown and larger specific capacity than if the true static level was measured and used for the calculations. Specific capacities for most City wells have ranged from about 20 to 120 gpm per foot of drawdown.

Table 6.9-1: Summary of Pump Test Data for Clovis Wells

Well ID	Location	Pump Test Capacity (gpm)	Specific Capacity (gpm/ ft drawdown)	Pump Test Report Location
4AA	3300 Lind Ave	1,327	23	2006 Pump Test
8A	294 N. Villa	1,496	48	2006 Pump Test
11	1722 Fowler	1,120	93	2009 Pump Test
15A	599 Timmy	1,279	142	2009 Pump Test
		1,295	118	2006 Pump Test
17	1680 Willow	1,056	117	2009 Pump Test
		1,052	96	2006 Pump Test
21	640 W. Alluvial	820	27	2006 Pump Test
22	842 Alluvial	647	24	2009 Pump Test
		591	16	2006 Pump Test
29	820 W. Pico	929	23	2006 Pump Test
30	1120 N. Sunnyside	720	38	2006 Pump Test
36	685 W. Nees	177	44	2004 Pump Test
40	2819 Fowler	1,120	93	2009 Pump Test
		767	12	2006 Pump Test
		767	12	2004 Pump Test

Table 6.9-2 summarizes the results of aquifer tests that have been conducted on City of Clovis wells developed since the previous Water Master Plan Update. In this case, specific capacity values were determined based on the true static water levels. Specific capacities ranged from 4 to 52 gpm per foot. Transmissivity is an indication of the capability of an aquifer to transmit water through a specific width of the aquifer. Aquifer transmissivity ranged from 3,800 to 96,000 gpd per foot, and averaged 53,800 gpd per foot for the wells shown. The highest transmissivities are in a southwest-northeast zone between Herndon and Ashlan Avenues, and appear to tap sub-surface deposits associated with a formal channel of Big Dry Creek. Transmissivities decrease, both to the west and southeast, away from the buried channel. The lowest transmissivity in the study area is near Shaw and Fowler Avenues where there are predominantly fine-grained deposits in the subsurface.

Table 6.9-2: Summary of Aquifer Tests for Clovis Wells

Well ID	Date	Perforated Interval (ft)	Pumping Rate (gpm)	Static Level (ft)	Pumping Level (ft)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)
5A	7/7/2003	350-650	1,265	173	243.1	70.1	18	42,000
7A	10/9/2012	340-650	1,995	188	234.7	46.7	43	89,000
32	12/19/2001	230-510	1,300	122.4	171.3	46.7	28	47,000
33	9/25/2000	130-330 & Open-Bottom at 405	890	66.1	107.9	41.8	21	45,000
34	3/25/2002	280-405	1,470	159.4	194.9	35.5	36	59,000
36	4/3/2002	200-480	1,105	149.5	182.3	32.8	34	71,000
37	2/17/2003	295-465	2,510	136.4	185.2	48.8	51	96,000
38	1/30/2003	230-410	2,200	138.4	203.1	64.7	34	72,000
39	6/19/2004	330-650	1,500	202.8	275.8	73	20	36,000
40	3/17/2003	355-695	720	157	332.6	175.6	4	3,800
41	3/7/2003	250-470	1,730	152.5	185.6	33.1	52	70,000
42	4/22/2004	245-660	2,510	113.6	183.1	69.5	36	91,000
43	3/1/2004	230-445	2,015	130.6	191.7	61.1	33	60,000

6.9.1 Specific Yield

Page and LeBlanc (1969) presented estimates of specific yield for the Fresno area. John Carollo Engineers and Harshbarger & Associates (1969) utilized an average specific yield of 0.13 for the older alluvium in the urban area. Average values for the under-lying continental deposits probably range from about 0.07 to 0.10, based on the predominant fine-grained texture of these deposits. Specific yield values can be used along with water level changes to estimate changes in groundwater storage.

The average water level-decline in the City's wells from 2007 to 2014 was 1.5 feet per year. These wells represent an area of about 15,200 acres. The specific yield is the percentage of saturated aquifer materials which will freely drain water. Using an average specific yield of 12 percent, based on previous hydrogeologic studies in the area, the change in storage averaged about 2,740 acre-feet per year (15,200 acres x 1.5 ft/yr x 0.12) during that period within the city limits. When extrapolated over the acreage associated with the SOI boundary (21,100 acres) and the General Plan boundary (47,500 acres), the change in storage is 3,800 and 8,550 acre-feet per year, respectively..

6.10 Pumpage and Intentional Recharge

Pumpage by the City of Clovis increased from about 7,900 acre-feet per year in 1980 to a high of 23,000 acre-feet in 2004 and has since declined to 15,500 acre-feet in 2014. In 2014, the pumpage by the City of Clovis was about twelve (12) percent of the total pumpage for public supply in the entire Fresno-Clovis urban area[11].

Recharge at the Clovis Basin west of Tarpey Village began in 1974 and in flood control basins and stream channels in or up-gradient of the City in 1982. Intentional recharge in the City of Clovis during 1974-94 ranged from about 2,500 acre-feet in 1987 to 10,700 acre-feet per year in 1992 (see **Table 6-10.1**).

Management of storm waters by FMFCD improves the water balance condition for the City by capturing storm water and recharging through flood control facilities scattered across FMFCD's district boundaries including nearly thirty basins in Clovis. Within the study area identified in **Figure 6.10-1**, FMFCD has a total of 33 basins. Most of these basins are located west of the Enterprise Canal. FMFCD uses the flood control basins in a variety of ways that benefit both the aquifer (dedicated recharge basin) and the community (combination recharge basin and park). Water is delivered to these facilities through FID and FMFCD infrastructure.

[11] In 2014, the City of Fresno pumped 110,300 AF and Bakman Water Company pumped 3,700 AF. Combined with the City of Clovis, a total of 129,500 AF was pumped by these three major suppliers (other minor amounts pumped by private well owners and small utility companies are not accounted for in this quantity).

Table 6.10-1: Summary of Historic Intentional Recharge

Year	Clovis Basin	FMFCD Subtotal	Marion Recharge Facility	Big Dry Creek	Totals
1974	3,179	--	--	--	3,179
1975	5,021	--	--	--	5,021
1976	3,540	--	--	--	3,540
1977	2,845	--	--	--	2,845
1978	6,397	--	--	--	6,397
1979	6,952	--	--	--	6,952
1980	6,751	--	--	--	6,751
1981	4,930	--	--	--	4,930
1982	4,521	1,606	--	1,434	7,561
1983	3,927	884	--	5,317	10,128
1984	3,427	1,491	--	3,837	8,755
1985	2,419	260	--	2,294	4,973
1986	3,146	1,252	--	3,080	7,478
1987	1,601	782	--	847	3,230
1988	1,490	1,130	--	812	3,432
1989	3,961	1,580	--	1,102	6,643
1990	2,156	1,335	--	1,949	5,440
1991	3,278	1,694	--	2,635	7,607
1992	3,208	1,583	--	3,169	7,960
1993	2,041	2,491	--	4,748	9,280
1994	1,563	2,236	--	2,739	6,538
1995	1,967	1,620	256	4,908	8,751
1996	1,334	3,160	2,530	4,000	11,024
1997	733	1,626	1,979	5,120	9,458
1998	738	1,713	2,745	5,515	10,711
1999	--	2,678	2,009	5,185	9,872
2000	--	2,202	1,740	5,966	9,908
2001	--	2,341	2,733	4,959	10,033
2002	--	1,725	2,139	4,868	8,732
2003	--	1,902	1,056	4,946	7,904
2004	--	2,147	3,661	4,566	10,374
2005	--	2,045	4,731	3,620	10,396
2006	--	1,666	4,499	3,082	9,247
2007	--	727	3,214	1,869	5,810
2008	--	2,521	3,415	2,792	8,728
2009	--	2,233	2,986	2,779	7,998
2010	--	1,944	2,681	3,741	8,366
2011	--	2,292	2,053	3,777	8,122
2012	--	2,815	4,140	2,670	9,625
2013	--	1,936	3,548	2,448	7,932
2014	--	210	963	1,275	2,448
Average	3,245	1,752	2,654	3,395	7,417
Total	**81,125**	**57,827**	**53,078**	**112,049**	**304,079**

Notes:
1. Some monthly figures were reduced for maximum recharge delivery of 1,000 AF per month to Big Dry Creek.
2. Big Dry Creek figures do not include volumes of water delivered to Marion Recharge Facility
3. Recharge figures are for February through March
4. Recharge figures do not include delivery system recharge charged by FID since 2005 when the cities of Clovis and Fresno Surface Water Treatment Plants are the only users on the system.
5. FMFCD recharge does not include stormwater.

Figure 6.10-1: Stormwater Recharge Basins

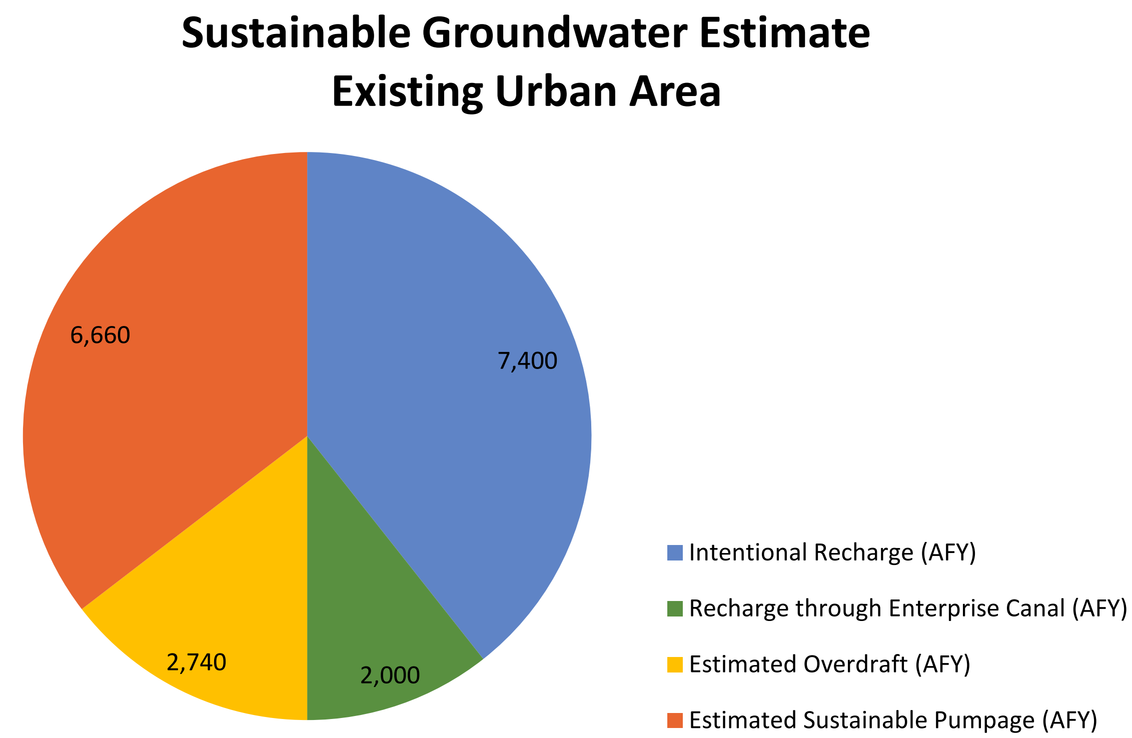
6.11 Estimate of Sustainable Pumping

The City of Clovis has been able to pump groundwater for its constituency due to the fact that there is natural recharge that accrues to the study area as well as the intentional efforts of the City to artificially recharge the aquifer. In the Water Master Plan Phase 1, an estimate was made of the water budget at that time. It was previously estimated that the long term sustainable pumpage without intentional efforts was 7,700 af per year. This same analysis was performed as part of the Phase II Water Master Plan Update. The Phase II report stated that the estimated sustainable long term groundwater yield in the urban area without intentional recharge is about 8,000 af per year. Hydrographs were evaluated for change in levels and correlated to the amount of imported surface water and then compared to the pumpage of groundwater. **Table 6.11-1** lists the values and computation that estimates the long term sustainable pumping. **Figure 6.11-1** shows a graphical representation of the values in the table.

Table 6.11-1: Long Term Sustainable Pumping

Parameter	Value (AFY)
Average System Demand	24,400
Average Groundwater Pumping	18,800
Average Treated Surface Water	6,900
Supply Total	25,700
Average Groundwater Pumping	18,800
Average Intentional Recharge	7,400
Estimated Recharge through Enterprise Canal	2,000
Estimated Overdraft	2,740
Estimated Sustainable Pumpage for Existing Urban Area	**6,660**

Notes:
1. Average supply and demands were calculated using data from the past 10 years.
2. Existing urban area 15,200 acres
3. Estimated Sustainable Pumpage for SOI – 9,400 AF



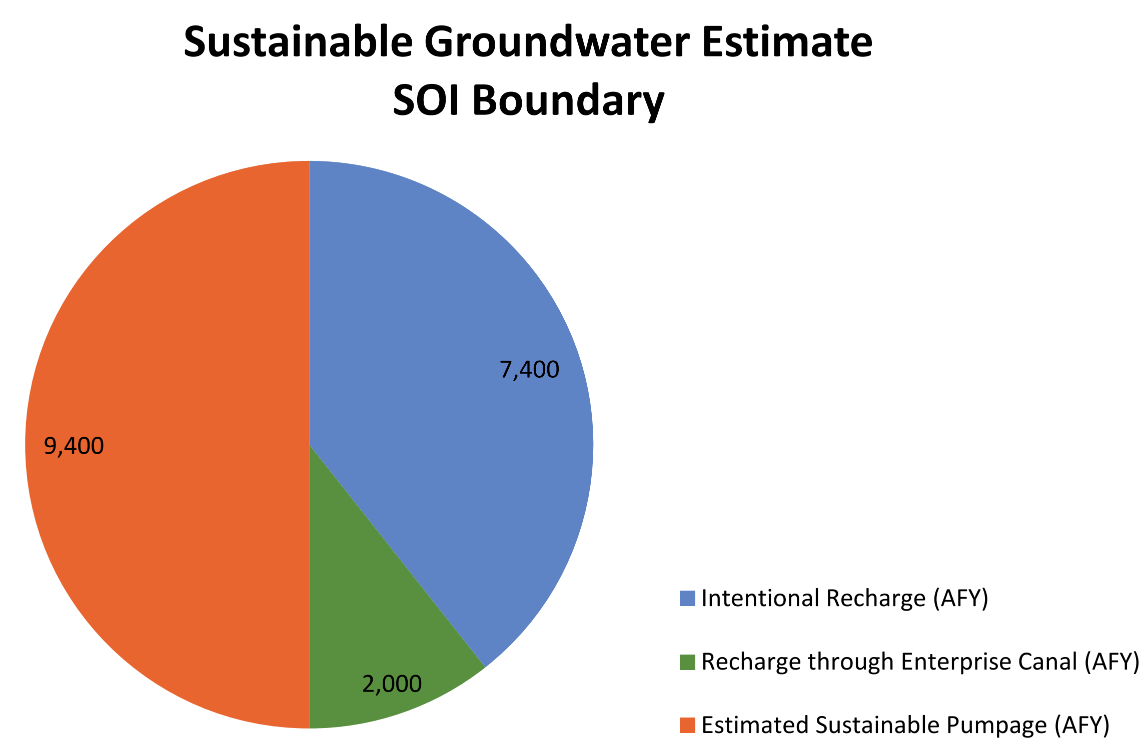


Figure 6.11-1: Sustainable Groundwater Pumping Evaluation

The sustainable pumping value is lower than in the previous reports and is likely due to a number of factors including, conversion of agricultural lands to urban uses and the lack of deep percolation of surface water from irrigation, less surface water deliveries to agricultural lands, removal of irrigation facilities and the loss of recharge through these systems, and the creation of more hardscapes from development and the capture and discharge of storm waters to the FID systems and export of storm water from the area. It should also be recognized with the anticipated conversion from supplying the City of Fresno Surface Water Treatment Plant via a pipeline from the Friant Kern Canal that the Enterprise Canal will be expected to be dry downstream of Dry Creek a portion of the year in the future as opposed to be constantly wet as has been the past practice. As can be seen above with the drying of the canal a significant reduction of recharge is expected to have an impact on the estimated sustainable pumpage identified above.

6.12 Groundwater Quality

Groundwater quality conditions and impacts were discussed in the City of Clovis Water Master Plan Update – Phase I. Significant constituents that have been monitored and identified within the general area include ethylene dibromide (EDB), dibromochloropropane (DBCP), and nitrate. The City of Clovis has previously mitigated the existence of the DBCP in the groundwater either by drilling deeper wells or through carbon absorption processes, although several wells have GAC treatment in place, also.

The Water Master Plan Update, Phase I and II discussed several groundwater quality problems, including nitrate, iron, manganese, DBCP, and ethylene dibromide (EDB). Nitrate concentrations exceeding the maximum contaminant level (MCL) of 45 mg/l (now regulated as 10 mg/l as N) were present in two large areas. One was north of the Enterprise Canal, primarily between Clovis and Armstrong Avenues. The second was primarily east of DeWolf Avenue, between Shaw and Shields Avenues. The first of these was largely a rural or rural residential area and the second was an irrigated area. Nitrate concentrations were less than 25 mg/1 in water from most City wells, except in the older part of the City, where they were higher, but less than the MCL. High iron and/or manganese concentrations were previously found in East Clovis by Kenneth D. Schmidt & Associates (KDSA) based on sampling of water from numerous private wells. This area was primarily between Barstow and Shields Avenues and Fowler and Leonard Avenues.

DBCP concentrations exceeding the MCL of 0.2 ppb were present in groundwater in several areas. One was in part of the Herndon-Shepherd plan area, and another was north of Shepherd Avenue and west of Peach Avenue. DBCP concentrations exceeding the MCL were also present northeast of the Fresno Air Terminal. There were two areas where EDB concentrations in groundwater exceeded the MCL of 0.05 ppb. One was between Alluvial and Nees Avenues and Clovis and Fowler Avenues. The second was largely between Barstow and Gettysburg Avenues and Fowler and Locan Avenues.

Sampling of private wells within the study area has generally not been conducted since the 1995 plan update. Thus updated results are based almost entirely on sampling of water from City supply wells.

6.13 Inorganic Chemicals

6.13.1 Aerial Distribution

Four inorganic chemical constituents in groundwater in the area were selected for detailed discussion, based primarily on their importance to water use. Total dissolved solids (TDS) is an indication of the salinity of water, but was not mapped because contents in the groundwater study area are relatively low. Nitrate was selected because it has been one of the most important inorganic chemical constituents in groundwater of the urban area for decades. It is the only inorganic chemical constituent in the Primary Drinking Water Standards to have been found in amounts exceeding the maximum contaminant level (MCL) in water from some large-capacity wells in the Fresno/Clovis area. Manganese was selected because concentrations exceeding the recommended MCL are common in the groundwater east of Clovis, near Dry Creek, and near the Clovis Basin. Iron was selected because of its occurrence in the east Clovis area. The manganese and iron do not have health-based MCLs, however, their presence in water at excessive levels causes objectionable characteristics, such as color and odor.

The quality of groundwater in a local area (i.e., near a source of contamination) may be different than shown by the results of supply well sampling. This is because the sampled supply may not be perforated shallow enough to reach the contamination and they may not be located in the contamination plume. Monitor wells are usually necessary to delineate plumes from point sources. The quality of water pumped from a well also depends on the design of the well, because there are usually significant vertical variations in groundwater quality. Thus the quality of water pumped from shallow wells often is not the same as that of water pumped from deep wells, even in the same vicinity.

6.13.2 Total Dissolved Solids

In 1989-91, TDS concentrations of less than 100 mg/L were present only beneath and down gradient of the Clovis Basin and Fresno's Leaky Acres. The relatively low salinity of groundwater in this part of the urban area is due to the intentional recharge of low salinity canal water for two decades. Although the low salinity groundwater is considered beneficial in most aspects, it has a higher corrosiveness than other groundwater in the urban area. TDS concentrations in groundwater beneath the northern half of the Fresno-Clovis urban area normally range from about 100 to 250 mg/L, well below the secondary MCL of 1,000 mg/L.

6.13.3 Nitrate

A drinking water limit has been established for decades for nitrate, as excessive concentrations in drinking water can cause methemoglobinemia (blue babies). Nitrate concentrations in groundwater in most of the Clovis urban area are less than the MCL of 45 mg/L. Nitrate levels for select wells are shown in **Figure 6.13-1**.

High nitrate concentrations, ranging from 40 to 46 mg/I, were found in City Well No. 11 during 2011-2014, and the well was taken out of service. This well is located near Gettysburg Avenue, east of Clovis Avenue. The source of the high nitrate concentrations in water from this well was apparently former fertilizer applications to irrigated land. Nitrate concentrations ranging from 30 to 35 mg/1 were present in water from City Well No. 18 during 2011-14. This well is located south of Tarpey Village near the former Italian Swiss

Colony Winery Wastewater disposal area, which is the most likely source of the elevated nitrate concentrations. Nitrate concentrations ranged from 30 to 36 mg/1 and water from Well No. 34 during 2011-14. This well is located near Teague and Willow Avenues, and the source of the elevated nitrate concentrations has not been determined. Nitrate concentrations in water from City Well No. 36 ranged from 31 to 42 mg/1 during 2011-14. This well is located near Nees Avenue, east of Willow, half a mile south of Well 34. The source of nitrate in water from this well has also not been determined.

Although high nitrate concentrations have caused several shallow public supply wells in the Fresno urban area to be closed, construction of deeper wells with adequate annular seals has been demonstrated to be effective in mitigating this problem. Such mitigation has been successfully practiced in this area for more than two decades.

6.13.4 Manganese

The recommended MCL for manganese in public water supplies is 0.05 mg/L. Historically, only a few public-supply wells in the Fresno-Clovis urban area have produced water exceeding the MCL for manganese. Elevated Manganese levels have become more noticeable with expansion of the urban area to the east, particularly in Wells 31 and 40, where the Manganese levels were 130 and 69 mg/L, respectively in 2014, correlating to the City's previous knowledge of the highest manganese concentration being in east Clovis. The City currently has treatment installed at Well 16 and four additional wells (Wells 20, 31, 39, and 40) on standby or in low use due to Manganese. Well 16 is located near Armstrong and Gettysburg Avenues, Well 20 is located near Armstrong and Barstow Avenues, Well 31 located near Leonard and Ashlan Avenues, Well 39 is located near Willow and Herndon Avenues, and Well 40 located near Fowler and Gettysburg Avenues. Manganese levels for select wells are shown in **Figure 6.13-2**Error! Reference source not found..

6.13.1 Iron

The recommended MCL for iron in public water supplies is 0.3 mg/L. Historically, few public-supply wells in the Fresno-Clovis urban area have produced water exceeding the MCL. City of Fresno Well No. 101, located east of Fresno Yosemite International Airport (formerly known as Fresno Air Terminal), is periodically treated because its iron concentrations exceed the MCL. City of Clovis wells that exceed the MCL for Iron are generally south of Barstow Avenue, along Fowler Avenue and farther to the east into Loma Vista. Iron levels for select wells are shown in **Figure 6.13-3**.

6.13.1 Arsenic

The present MCL for arsenic is 10 ppb. Arsenic concentrations in the water from most City wells ranged from non-detect to 3 ppb; therefore Arsenic contamination is not considered a critical issue for the City.

Figure 6.13-1: Nitrate Concentrations in Well Water

Figure 6.13-2: Manganese Concentrations in Well Water

Figure 6.13-3: Iron Concentrations in Well Water

6.13.2 Vertical Distribution

The vertical distribution of constituents in the groundwater can be determined in several ways. First, water samples can be collected from specially designed and constructed test wells or the pilot holes for new wells. Second, wells are sometimes deepened, or replaced by adjacent deeper wells. The quality of water pumped from the well can be compared before and after deepening. Sometimes there are adjacent wells of different depth that can be compared. Open-bottomed or unperforated casing wells provide extremely useful information related to vertical differences in groundwater quality, since they produce water from specific strata, as opposed to gravel packed wells with perforations extending over several hundred feet in depth. Third, specially designed monitor wells tapping groundwater in discrete depth intervals can be installed and monitored.

In general, data indicates that the quality of groundwater in much of the urban area usually improves with increasing depth to at least about 400 feet. An exception is in part of the east Clovis area (east of Clovis Ave and south of Shaw), where reduced (blue-green) deposits are encountered below that depth. Groundwater in these deposits is present under anaerobic (oxygen deficient) or reduced conditions and can have high concentrations of iron, manganese, arsenic, and hydrogen sulfide.

Groundwater of high salinity (connate water) underlies the usable groundwater in the Fresno area, except beneath the eastern part. Page and LeBlanc (1969, Plate 17) contoured the base of the fresh groundwater (top of the connate water). Fresh groundwater was defined as having a TDS concentration of less than 2,000 mg/L. The information that they used was primarily derived from interpretation of electric logs for deep oil or gas exploration wells west of Clovis. More recent data obtained from water wells and test holes have shown that the eastern edge of this body of connate water does not extend east of Pinedale. Test wells extending through the alluvium and down to bedrock in the Herndon-Shepherd Plan area have not encountered connate water.

In recent years, numerous test wells, and pilot hole sampling programs have been undertaken in the urban area. The results of these programs have confirmed that TDS, nitrate, and hardness concentrations in the groundwater normally decrease with increasing depth, particularly beneath areas that were formerly un-sewered or were irrigated. Groundwater in the older alluvium is normally aerobic (i.e. oxygen rich) or oxidized. Groundwater in the deeper reduced, underlying continental deposits, on the other hand, is usually reduced. The quality of groundwater below a depth of about 250 feet in most of the area has normally not been affected by human's activities. TDS, nitrate, and hardness concentrations in this deeper groundwater are normally low, but significant concentrations of iron, manganese, hydrogen sulfide, and sometimes arsenic can be present, particularly in deposits that are blue or green in color. The blue-green deposits are particularly important where they are present above a depth of about 500 feet, such as in parts of the east Clovis area. At greater depths, they are usually too deep to be tapped by water wells. Information from test hole T13S/21E-22D, that was drilled east of Fowler Avenue, and about one-quarter mile south of Ashlan Avenue, delineated the vertical distribution of manganese in groundwater at that location. The manganese concentrations ranged from 0.06 to 0.19 mg/L exceeding the recommended MCL, above a depth of 270 feet at this location.

Within the east part of the study area, methane gas was reported in water from a relatively shallow well tapping groundwater in bedrock beneath the alluvium. The extent of the methane gas has not been determined, although such an occurrence in groundwater in the Fresno-Clovis area is highly unusual. Methane is more common in groundwater farther west and south of Fresno, such as in the Corcoran area.

6.14 Trace Organic Chemicals and Radiological

The primary trace organic chemical constituents that have been found at significant levels in water from public-supply wells in the Clovis urban area are DBCP and 1,2,3-Tricholoropropane (1,2,3-TCP). Several volatile halocarbons including trichloroethylene (TCE) and tetrachloroethylene (PCE), have been found in parts of the Fresno urban area. In terms of amount of contaminated groundwater, the largest problem by far is due to DBCP and 1,2,3-TCP. TCP was in 1,2,3-D soil fumigants applied to control nematodes and was in significant use from the 1940s to 1990.

6.14.1 DBCP

A report was prepared for the City of Fresno on the adjacent North Fresno Growth Area (Kenneth D. Schmidt and Associates, 1987) that included data from nineteen private domestic wells that were sampled for DBCP analysis in spring 1987. These wells were sampled because of the desire to obtain information prior to intensive urbanization. In May 1991, J.H. Kleinfelder and Associates, under contract to the City for Fresno, sampled water from twenty-one private wells in and near the north part of the North Fresno Growth Area for DBCP analyses.

About 30 private domestic wells in the Herndon-Shepherd Plan area were sampled in spring 1989, and about three dozen private wells in the east Clovis area were sampled in June 1990 by Kenneth D. Schmidt and Associates, as part of studies for the City of Clovis. Results of sampling of private domestic wells and small water systems were also available from the County of Fresno Environmental Health.

A map of DBCP concentrations in groundwater in 1989-91 in and near the Fresno-Clovis urban area was presented in the Fresno Water Management Plan report (Kenneth D. Schmidt and Associates, 1991). Two large areas of high DBCP concentrations were present, one in southeast Fresno and one in northeast Fresno. The latter of these two areas includes the western part of the Herndon-Shepherd Plan Area. In 2011-2014, DBCP concentrations exceeding the MCL of 0.20 ppb were present in water from four City of Clovis wells in this area. The highest DBCP concentrations were present in a northeast band extending from Herndon and Peach Avenues to Willow and Teague Avenues. DBCP sampling results in excess of the MCL from 2011 through 2014 are shown in **Table 6.14-1**. These wells are also shown on **Figure 6.14-1**. Considering the detection areas discussed in the Phase II Water Master Plan and the direction of groundwater flow, DBCP is moving southwest or west and out of the City of Clovis.

Table 6.14-1: Sampling Data for DBCP

Well No.	Sample Quarter / DBCP Concentration (ppb)											
	3rd Q 2011	4th Q 2011	1st Q 2012	2nd Q 2012	3rd Q 2012	4th Q 2012	1st Q 2013	2nd Q 2013	3rd Q 2013	4th Q 2013	1st Q 2014	2nd Q 2014
21	0.31	0.28	0.21	0.32	0.30	0.32	0.23	0.24	0.26	0.29	0.22	0.28
27	0.34	0.42	0.31	0.32	0.39	0.37	0.32	0.26	0.30	0.28	0.26	0.31
34							0.22					
36	0.41	0.53	0.57	0.46	0.49	0.53	0.51	0.35	0.36	0.38	0.35	0.44
T-6						0.20						
T-8	0.21	0.25	0.21	0.24	0.21	0.24	0.20	0.28	0.20	0.25	0.23	0.25

6.14.2 TCP

1,2,3-TCP does not have an adopted MCL at this time; however, it does have a Public Health Goal (PHG) of 5 parts per trillion (ppt). Concentrations ranging from 5 to 12 parts ppt were detected in the water from City Well No. 11 during 2011-14. This well is offline due to high nitrate concentrations (discussed previously). TCP concentrations ranging from 6 to 9 ppt were detected in the water from City Well No. 12 during 2011-14. TCP concentrations ranging from 7 to 10 ppt were detected in the water from City Well No. 18 during 2011-14. Water from Well No. 21 had TCP concentrations ranging from 4 to 6 ppt during 2011-14, which is also being treated for DBCP contamination. TCP concentrations in the water supply from other City wells were generally less than 6 ppt. It is expected that these and other wells will require treatment due to a pending Maximum Contaminant Level for TCP. 1,2,3-TCP sampling results in excess of the PHG from 2011 through 2014 are shown in **Table 6.14-2**.

Table 6.14-2: Sampling Data for 1,2,3-TCP

Well No.	Sample Quarter / 1,2,3-TCP Concentration (ppt)		
	3rd Q 2011	4th Q 2012	2nd Q 2014
7	6.0		
11	12.0	5.1	10.0
12	9.0	7.2	6.0
18	10.0	6.9	8.0
21	6.0		
28	16	9.3	7.0

Figure 6.14-1: DBCP Concentrations in Well Water

6.14.3 Vertical Trends

Ten casing hammer test wells were completed in the Herndon-Shepherd Plan area during 1989-91, partly to determine the vertical distribution of DBCP at prospective sites for new City of Clovis public-supply wells. Results of these test wells illustrated two predominant patterns. First, clay strata in part of this area aren't highly effective as confining layers. At three test well sites in this area, DBCP had migrated to depths exceeding 300 feet which is significantly deeper than normally found in surrounding areas. However, DBCP concentrations exceeding the MCL weren't found in any of the test wells below a depth of 260 feet. The relatively shallow bedrock in the northeast part of this area is a substantial constraint in developing new public-supply wells. The results from the 1989 sampling of water from shallow private domestic wells indicated that the shallow groundwater near Dry Creek had low DBCP concentrations. However, the subsequent drilling of several test wells in this area indicated that high DBCP concentrations were generally present in groundwater below a depth of about 120 feet and above a depth of about 250 feet. Recent recharge from streamflow in Dry Creek is apparently the source of the shallow groundwater in this area, which has low DBCP concentrations. This recharge probably originated after the use of DBCP was banned.

Two casing hammer test wells have been drilled in the east Clovis area, one near Ashlan and Fowler Avenues (T13S/R21E-22D), and another TH-92A farther east. No DBCP was detected in the groundwater at either of these sites.

6.14.4 Ethylene Dibromide

Two areas of ethylene dibromide (EDB) concentrations exceeding the MCL of 0.02 ppb have been found in the Herndon-Shepherd Plan area. One was found in a test hole (TH-89A) near Villa and Herndon. This well is in an area of high DBCP contents in the shallow groundwater. Another is in a triangular shaped area between Herndon and Nees Avenues and Marion and Fowler Avenues. City of Clovis Well No. 24 was drilled in this area, but was sealed off opposite shallow strata and has been free of EDB. Based on sampling results for numerous other wells in the plan area, which have had no detectable EDB, the occurrence of EDB in groundwater appears to be highly localized. The source appears to be pesticide applications to agricultural lands in close proximity to the sampled wells.

In the east Clovis area, a zone of EDB concentrations in shallow groundwater exceeding the MCL was found between Barstow and Gettysburg and Fowler and Temperance Avenues. Two City wells (13 and 16) were located in this area, and EDB concentrations in water from them ranged from less than 0.02 ppb to 0.10 ppb in 1990. Water from well 13 had EDB concentrations exceeding the MCL during 1990, but since that time concentrations have been non-detectable and the well has now been destroyed. Well 16 has also not had any detectable EDB since manganese treatment was installed in 1999. The source of the EDB in this area is also believed to be pesticide applications on agricultural lands in the close proximity to the sampled wells.

6.14.5 Vertical Halocarbons

Although volatile halocarbons have been a problem in groundwater in other parts of the Fresno-Clovis urban area, they do not appear to be a problem in Clovis at present, based on sampling of water from City wells.

6.14.6 Radiological - Radon

Presently there is no MCL for radon in groundwater, but an MCL of 300 picocuries per liter has been proposed by the EPA. The radon activities in water from city wells ranged from 318 to 1,365 and averaged 449 picocuries per liter in 1993. The highest activities (exceeding 600 picocuries per liter) were in water from wells west of Clovis Ave. The lowest activities (less than 400 picocuries per liter) were in Water from wells east of Clovis Ave. Thus an MCL as low as proposed could have a significant impact.

7 Surface Water Supplies

The purpose of this chapter is to identify and quantify the various sources of surface water that are and will play a role in meeting existing and future water demands within the City's service area. The City currently has access to Kings River water through agreements with the Fresno Irrigation District (FID), and as the City continues to grow to the north and northeast, Clovis should plan for opportunities to access Central Valley Project[12] water from other nearby agricultural water districts. Phases I and II of the Water Master Plan Update, prepared in 1995 and 1999, respectively, provided an in-depth review of many of the characteristics of both ground and surface waters. This study updates information presented in these reports and expands on issues that have changed since that time.

As is described in Chapter 3, Section 3.2, the planning area boundaries identified previously have shifted and unit demands have changed over the years for some urban land use designations. The revised boundaries were utilized for the development of both the water demand as well as projected water supplies values utilized for analysis in this report.

7.1 Climate

The climate for the study area is characterized as being semi-arid, with hot dry summers, cool winters, and mild spring and fall. The City is located at the base of the foothills of the Sierra Nevada Mountains, so temperature and precipitation vary slightly from the valley floor. Long-term local climate data is collected at the Fresno-Yosemite International Airport, which is the closest weather station to the study area. The data shows this region has an average temperature of 64 degrees Fahrenheit and receiving about 11 inches of precipitation annually. **Table 7.1-1** provides average monthly temperatures, with the maximum and minimum temperatures for the period from 1948 to 2014. Also included in this table are average monthly precipitation amounts.

The City measures annual precipitation on a rain year (RY) from July to June as opposed to a calendar year. Annual precipitation (see **Figure 7.1-1**) for the area ranges from about 5 inches in dry years to about 23 inches in wet years. The average annual precipitation for the area based on a period from 1948 to 2014 is about 11 inches with 93 percent occurring from October through April and the summer months being predominantly dry. During this 67 year period, record low precipitation was seen in the rain year from July 2013 through June 2014 with 4.8 inches while a record high of nearly 23.6 inches occurred in the rain year from July 1982 through June 1983. Precipitation that does not infiltrate into the ground collects in flood control retention basins and local waterways that generally drain towards the southwest.

[12] Central Valley Project (CVP) is a federal water project constructed under the supervision of the United States Bureau of Reclamation. Main features of the Friant Division include: Friant Dam, Friant-Kern Canal, and Madera Cana.

Table 7.1-1: Summary of Climate Data for the Fresno/Clovis Metro Area.

	Temperature (°F)			Mean Precipitation (in)
Month	Mean	Maximum	Minimum	
January	46.3	55.3	38.8	2.01
February	51.1	61.7	42.0	1.87
March	55.6	67.8	45.6	1.85
April	61.3	74.9	49.4	1.03
May	69.0	84.1	56.0	0.36
June	76.2	92.3	62.1	0.16
July	82.1	98.2	67.2	0.01
August	80.3	97.0	66.0	0.01
September	75.3	90.5	61.1	0.15
October	65.6	79.4	52.8	0.52
November	54.0	63.2	42.5	1.11
December	46.2	55.2	38.6	1.63
Mean/Total	**63.6**	**76.6**	**52.0**	**10.7**

Notes:

1. Climate data obtained from the Western Regional Climate Center and the measurement location is the Fresno Yosemite International Airport.
2. Period of record for temperature and precipitation data is for 1948 -2014.
3. Mean precipitation is the mean of the monthly totals.
4. Mean temperature is an average of the monthly average values.

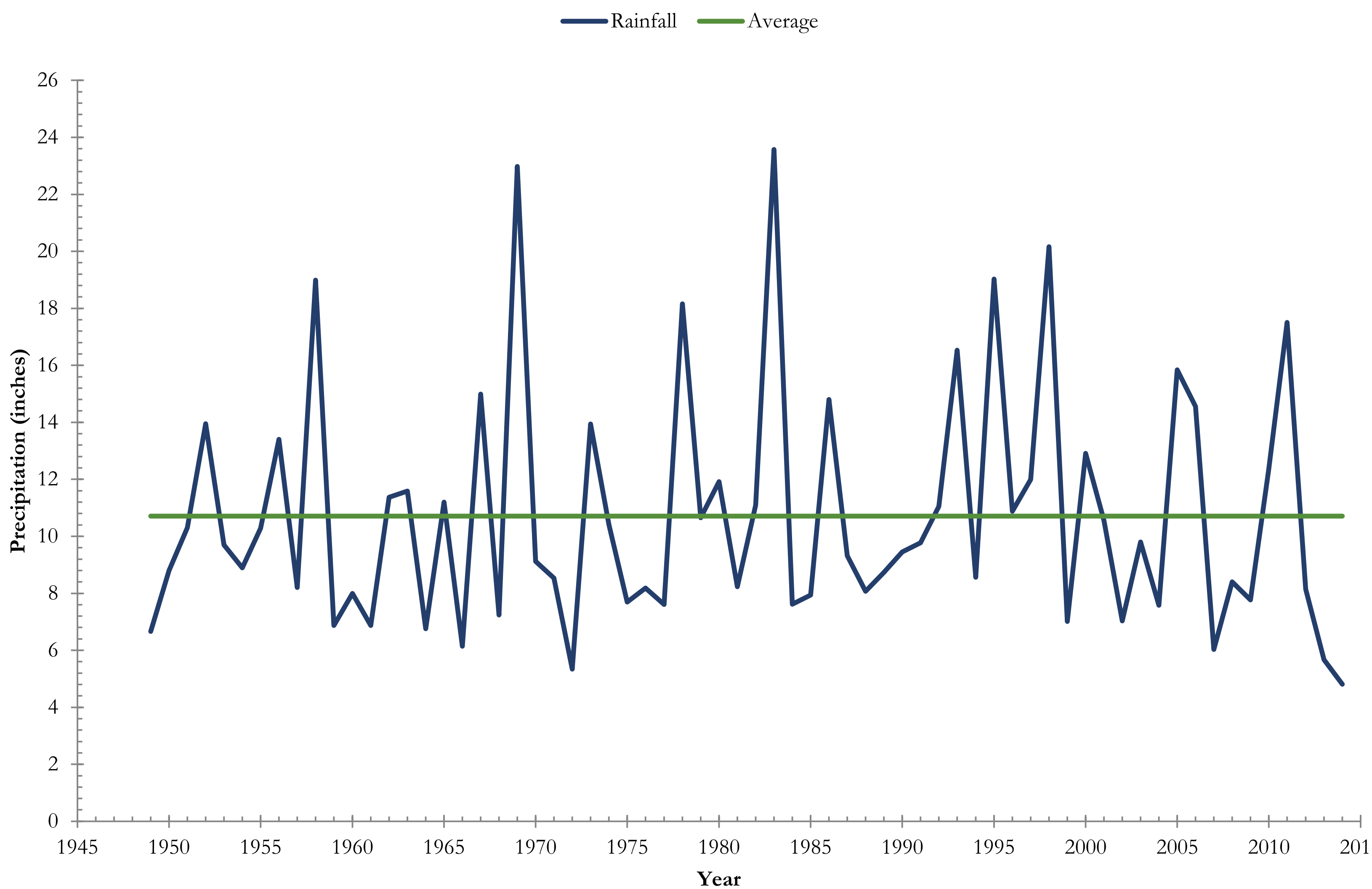


Figure 7.1-1: Annual Precipitation for the Fresno/Clovis Metropolitan Area

7.2 Existing Surface Water Supplies

The City is fortunate to be located between two major rivers, the Kings River and the San Joaquin River, which are key sources of surface water for many municipal and agricultural users in the Central Valley. Through cooperative agreements with FID the City has access to Kings River water, which will continue to grow as development within the City builds out in the FID service area. The City may also gain access to water from the Central Valley Project-Friant Division as development occurs within water district service areas holding CVP contracts for this water. Surface water supplies may be augmented through cooperative agreements for various water banking facilities.

Annual surface water supplies are based upon hydrologic conditions that are highly variable as shown in **Figure 7.1-1** above. The following discussion on surface water will describe the basic resource, the City's existing supply contracts, and will identify estimated quantities associated with the pertinent entities and contracts. Later, in Chapter 9, the reliability and firm yield of the supplies will be examined. **Table 7.2-1** provides a summary list of surface water supplies within the study area.

Table 7.2-1: Entities with Surface Water Supplies

Entity	Source	Use	Contract Number	Yield (AF)[5]
Fresno Irrigation District[1]	Kings River	Pre-1914[7]	KRWA[4]	424,200
Fresno Irrigation District	CVP-Class 2	M&I/Ag	14-06-200-1122A-D	75,000
Garfield Water District	CVP - Class 1	Ag	14-06-200-9421-D	3,500[2]
International Water District	CVP - Class 1	M&I/Ag	14-06-200-585A-LTR1	1,200
FID Waldron Pond Facility[6]	Various	M&I/Ag	FID-Clovis Agreement	10,000
FID Boswell Facility	Various	M&I/Ag	FID-Clovis Agreement	4,500
Cities of Fresno & Clovis, FID & FMFCD	Fresno Stream Group	M&I/Ag	SWRCB Application	10,000[4]

Notes:

1. FID's Kings River contract amount represents historical average annual entitlement for the past 30 years (1985-2015).
2. Full contract amount shown for Garfield Water District even though about 50 percent of it lies within Clovis future sphere of influence. Clovis would likely receive a prorated share, based on acreage, of this contract.
3. Fresno Stream Group appropriate right application has been submitted to SWRCB.
4. KRWA is the abbreviation for Kings River Water Association.
5. Ability to utilize available contract amounts depends of capacity of existing facilities.
6. Clovis is entitled to 90 percent of the annual yield from this facility.
7. Water rights established prior to the establishment of the State Water Resources Control Board.

7.2.1 Kings River

The Kings River has been a source of agricultural water supply for over a century. As the number of farm operations increased that utilized diverted Kings River water, legal battles for the supply ensued and persisted for decades. Eventually, water rights were resolved and focus turned to the construction of a dam on the river. Pine Flat Dam was constructed in 1954 by the United States Army Corps of Engineers (USACE) to control the flood damage caused by the river and provide storage for water supplies. Both the USACE and the Kings River Water Association (KRWA) are responsible for operation of Pine Flat Dam. KRWA acts as a trustee for member agencies and holds the water rights and storage rights licenses. The KRWA Watermaster administers diversion of Kings River water granted under these licenses. The surface waters must be used within the place of use defined in the licenses.

A Water Right Indenture dated May 3, 1927, and amended and supplemented on June 1, 1949, and September 3, 1963, covers the allocation of the water available under the Kings River licenses. The allocation of water among the KRWA member agencies is determined by applying a schedule for each month to the natural flow of the Kings River, as it would occur without reservoir storage above the historic Piedra gaging station. The calculated natural flow is often referred to as Pre-project Piedra. The allocation of water to each agency by this schedule is termed entitlement.

7.2.1.1 Fresno Irrigation

Although FID has entitlement to surface water from both the Kings River and San Joaquin River, it is water from the Kings River that makes up the greatest portion of its surface water entitlement. FID holds "low flow" rights to the Kings River, which means the percentage of total flow it may divert is higher during low flow events. So, for a given water year FID receives a greater entitlement if snow pack melts slowly than if runoff occurs rapidly.

For the period from 1985 through 2015, FID received (or would have received) an average annual entitlement from the Kings River of approximately 424,200 AF (**Figure 7.2-1**). In this period, the highest entitlement of Kings River water received was 651,130 AF in the 1994-95 Water Year, while the minimum amount was 127,468 AF (118,651 net AF) in the 2014-15 Water Year. An annual entitlement of 310,600 AF has occurred or been exceeded in eighty (80%) percent of the years on record.

As stated previously, FID gains entitlement of water from the Kings River based upon an entitlement table. Clovis receives a pro rata share, based on acreage, of this supply; see the Conveyance Agreement for additional information about distribution of this source. The average allocation is determined by dividing the annual average Kings River entitlement of 424,200 AF by FID's service area receiving surface water, 201,417 acre[13], which results in a unit entitlement of 2.11 AF/ac. This value represents how water is allocated to each acre of land within the FID service area.

7.2.2 Central Valley Project - Friant Division

The San Joaquin River is the water supply source that is captured and regulated for the Friant Division of the Central Valley Project. Friant Dam (Millerton Reservoir) is located on the San Joaquin River about 25 miles northeast of the city of Fresno. Friant Dam has a capacity of about 500,000 AF and is the principal storage facility for the Friant Division. Construction of the dam commenced in 1939. In 1944, the dam height was sufficient to allow small diversions into the Madera Canal. Dam construction was completed in 1947 with diversions into the Friant-Kern Canal starting in 1949. Full operation of Friant Dam did not occur however until 1951 when the Delta-Mendota Canal was completed. Prior to the completion of the canal construction,

[13] Value provided by Jim Irwin, FID Watermaster, in email on October 6, 2015.

water continued to be released from Friant Dam for the exchange contractors downstream. The exchange contractors are the San Joaquin River water rights holders who exchanged their use of natural river runoff for a substitute supply from the Delta-Mendota Canal.

Water made available from the Friant Division of the CVP may be assigned one of four possible classifications depending on hydrologic conditions. These classifications include:

> Class 1 Water – this water supply can be considered dependable in practically every year, with deficiencies only in very dry years.
>
> Class 2 Water - this water supply is available after Class 1 entitlements have been met and is much less dependable with regards to quantity and time of occurrence.
>
> Recovered Water Account – this water supply is made available, as conditions permit, to the Friant Division long-term water contractors in an effort to offset impacts to their supply associated with the San Joaquin River Restoration settlement.
>
> Section 215 Water – this water supply is available when there is an excess beyond entitlements and rights, typically occurring as surplus flood flow. Section 215 water is subordinate to Recover Water Account water for contractors with converted Section 9(d) Contracts.

The plan of the United States for the San Joaquin River was to acquire the water rights by purchase or providing a substitute water supply. Total water supplies were estimated to be 2,200,000 AFY. Of the previously stated quantity 800,000 AFY was designated as Class 1 Water, which is to be "dependable" in nature of delivery reliability. Approximately 1,400,000 AFY was designated as Class 2 Water which is characterized as "undependable" and will only be made available as hydrologic conditions permit, and as determined by USBR.

Recovered Water Account water is to be made available to the Friant Division long-term water contractors during wet hydrologic conditions at a cost of $10 per acre-foot to all Friant Division long-term contractors who experience a reduction in water deliveries due to the flows called for in the Settlement to restore the San Joaquin River.

Section 215 water is only available when Millerton Reservoir is in flood release. Although the Kings and San Joaquin Rivers have similar average annual runoff totals, Millerton Reservoir has only half the storage capacity of Pine Flat. As a consequence of the smaller reservoir capacity, there tend to be more frequent flood flow releases from Millerton Reservoir making at least small partial allocations of Section 215 water available to CVP Contractors on a nearly regular basis.

7.2.2.1 Fresno Irrigation District

In addition to Kings River water, FID has a contract with the US Bureau of Reclamation for 75,000 AF of Class 2 water from the Friant Division of the CVP. The contract was executed on July 20, 1964, with a 30-year term that expired on February 28, 1995. On January 20, 2001, FID renegotiated a long-term agreement with the Reclamation extending the contract to February 28, 2026. This contract was subsequently converted in 2010 to a Section 9(d) contract which provides the contract supply water in perpetuity.

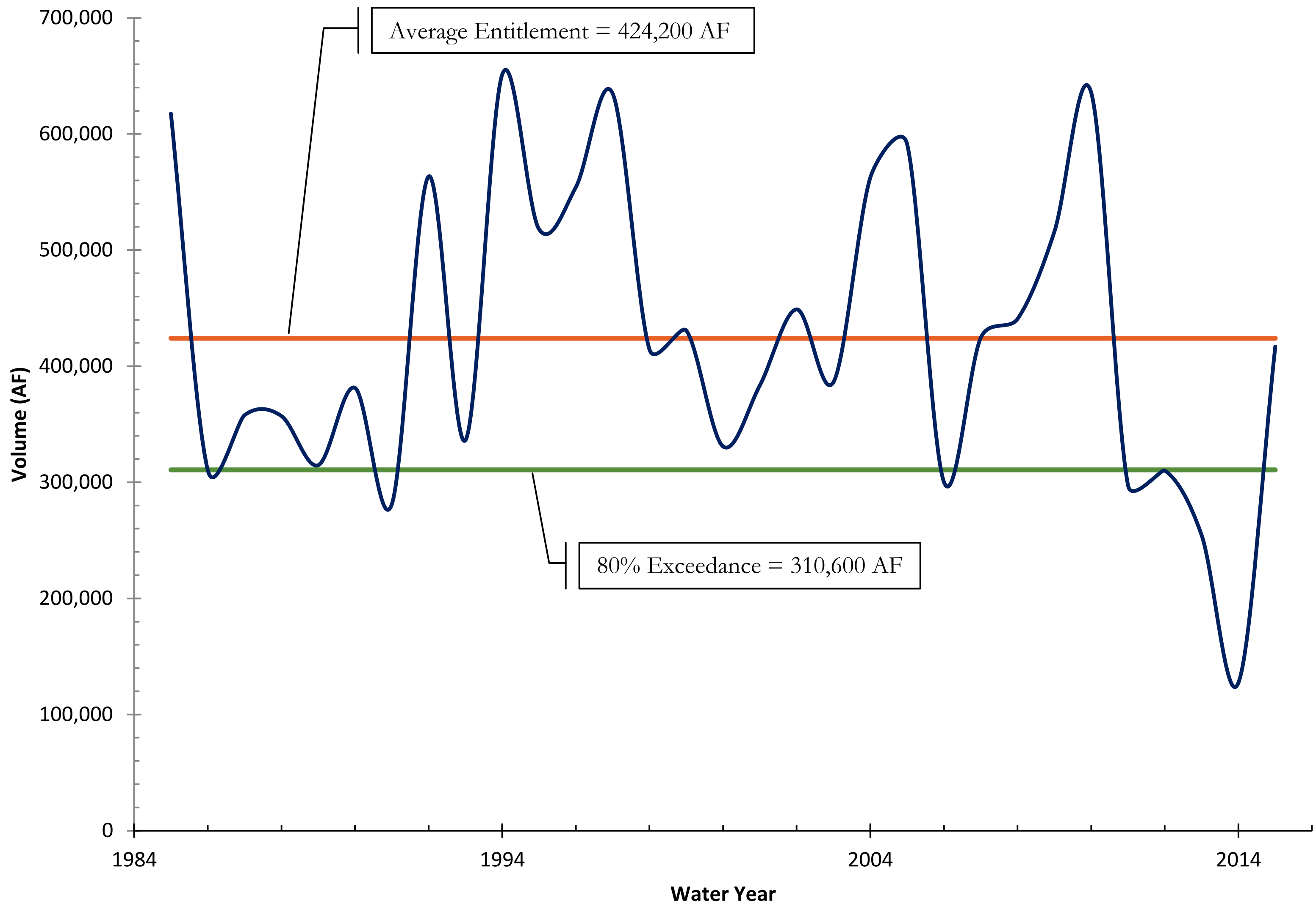


Figure 7.2-1: Fresno Irrigation District Average Annual Entitlement

The FID annexed lands (described in Section 2) are not entitled to receive Kings River water. These annexed lands are typically provided CVP Class 2 water supplies and on occasion Class 1 water through a separate purchase. As mentioned earlier, Class 2 water is usually only available in limited quantities and is not as reliable as the District's Kings River water supply. According to the District's Watermaster, average water deliveries to annexed lands totaled 200 AFY. FID annexed lands that have historically taken water are located in the Northeast Triangle, the Northeast Village, the Northeast Corner, and Between Canals study areas.

7.2.2.2 Garfield Water District

The Garfield Water District (GWD) has 50% of its service area within the Northwest Village and Northern Rural study areas and has a service contract with the USBR CVP Friant Division for 3,500 AF of Class 1 water. GWD renewed their long-term contract for the CVP water in 2001 however did not negotiate a change to the contract which would permit it to deliver water for municipal & industrial (M&I) purposes. The contract will expire in 2026 but can be renewed for an additional 25 years.

7.2.2.3 International Water District

The International Water District (IWD) service area is entirely within the Northeast Village study area and has a contract for 1,200 AF of Class 1 CVP water. In 2001, IWD renewed their long-term service contract and negotiated the provision to permit delivery of water for M&I purposes. This contract was subsequently changed in 2010 to a Section 9(d) contract which provides the contract water supply in perpetuity.

7.2.3 Fresno Stream Group

A joint application between the Cities of Clovis and Fresno, FID, and FMFCD was submitted to the State of California State Water Resources Control Board (SWRCB) to secure water rights from several streams comprising an isolated watershed located between the San Joaquin River and Kings River. The application states the water ". . . will be utilized first by the City of Fresno and City of Clovis in their respective service areas for direct deliveries to customers and/or groundwater recharge for subsequent delivery to customers." This water has historically been utilized within the region and the application seeking appropriative rights will formalize the claim to the water from the stream group. As this right is perfected, the City of Clovis will likely secure a proportionate share of this water right. The quantity of water that could be potentially captured and put to beneficial use may be in the order of 10,000 AF, in above normal water years. The true extent and frequency of availability will not be known until the SWRCB approves this appropriative right and additional measuring infrastructure is constructed to monitor and measure contributing flows.

7.3 Groundwater Banking Facilities

Groundwater banking involves storage within an aquifer, and recovery of stored water when needed. The ability to develop a groundwater banking facility depends on factors such as: available land, source of supply, water quality, soil type, aquifer characteristics, and recovery and extraction facilities. Three major benefits of a groundwater banking facility are: 1) capturing and storing surplus surface water supplies associated with "wet" hydrologic periods, 2) improving reliability of water resources (groundwater and surface water), and 3) diversifying a water supply portfolio.

7.3.1 Waldron Banking Facilities

In 2004, Clovis entered into an agreement with FID for the construction of the Waldron banking facilities. This agreement was structured such that the City paid for a portion of the capital facility costs and, in turn, receives a pro rata share of the annual water yield from the facility. The Waldron banking facilities encompasses approximately 225 acres of percolation basins and extraction wells. The facility is located about 3.5 miles east of the City of Kerman and has an estimated annual water yield of approximately 10,000 AF. The agreement stipulates the annual yield is the amount of water percolated during the current calendar year less a ten percent leave behind. The 'available annual yield' the City has access, in any given year, to ninety percent (90%) of the annual yield, or approximately 9,000 AF. Water pumped from Waldron Pond is delivered to FID users west of Kerman, and in exchange, FID delivers an equal amount of Kings River water to Clovis. In the event the City does not request all of the 'available annual yield' FID then may put the water to beneficial use as it deems appropriate. The City is entitled to any carryover water from previous years. The agreement also stipulates that in years when the facility's annual yield is less than the amount required by the City that FID will acquire additional water to meet the City's needs. The purpose of this program was to allow the City access to a dry year water supply to enable the planned surface water treatment plant to operate during dry and critically dry hydrologic conditions.

7.3.2 Boswell (Jameson) Facility

In August 2011, the City entered into another agreement with FID for the construction of a second groundwater banking facility known as the Boswell Facility (originally named the Jameson Facility). This facility encompasses, at buildout, about 100 acres of percolation basins and extractions wells. The Boswell Facility is located approximately 4 miles southeast of the city of Kerman. This facility was entirely paid for by the City and makes available to the City 4,500 AF, annually. The agreement stipulates that if the facility is unable to provide 4,500 AF, that at the City's request FID is to attempt to acquire supplemental water to make up the difference. The contract also stipulates the City may not carryover any unutilized water from one contract year to another. The purpose of adding this facility and water supply to Clovis' portfolio was to allow for water supply development to serve development outside the FID. It was recognized that FID Kings River water must stay within the FID. Essentially an internal exchange was accomplished whereby the FID surface water is delivered to users within the FID and groundwater is delivered to the lands outside the FID. The City enacted an ordinance to allow for costs to be recovered from the properties that were to receive the water.

These groundwater banking agreements are essential to the City having water supplies available to meet long-term goals and objectives. Water from these sources should also help the City avoid place of use restrictions associated with surface water supplies, which limit Clovis' ability to provide water service to outlying growth areas.

7.4 Summary of Surface Water Supplies

Utilizing the information presented in the preceding sections it is possible to estimate the amount of surface water supply that may be available to the City. The following discussions cover the amount of surface water that may be available to the City under present and future buildout conditions.

7.4.1 Present Surface Water Supplies

In August of 1972, the City of Clovis and FID executed an agreement making River water available to the City. The Agreement stipulated the City, on an annual basis, would receive a pro rata share of surface water supply based on the area of the City within FID's service area to the total area in the District receiving a "Surface Water Supply" from the District. The City is largely situated within the FID service area, but has begun to extend out beyond FID's boundaries. For the 2012/2013 water year, the City of Clovis had approximately 11,400 acres of land "included" within the FID boundaries, which equates to 5.67% of the nearly 304,400 AF of available supply for this particular Water Year, or about 17,300 AF. This example provides an understanding of how the water entitlement is computed each year, and highlights the variability of supply due to hydrologic conditions. The agreement excludes certain water from being available to the City by stating that any USBR Class 1 or Class 2 water the District receives will not be made available to the City but rather, a like amount of Kings River water will be provided to the City. The agreements further recognize that any water the District stores behind Pine Flat Reservoir will not be made available to the City. However, this supply is included in the total District "Surface Water Supply" and, as such, is included when calculating the City's share.

Surface water supplies are presently available to the City via the Waldron and Boswell Facilities. Water extracted from these facilities is provided in-kind from upstream sources. However, Waldron is a dry year supply and should not be used to provide water during average hydrologic conditions. The Groundwater bank supplies available to the City should the City elect to receive them are shown in Table 7.2-1.

7.4.2 Future Surface Water Supplies

Under the 1972 Conveyance Agreement, the accumulation of Kings River water supplies will continue as the City develops within FID's service area boundaries. For the Sphere of Influence (and General Plan) buildout condition, the City will occupy approximately 16,700 (17,400) acres of FID service area making approximately 35,100 (36,700) ac-ft of water accessible to the City under the normal water year condition. Chapter 10 will review the projected demands and supplies at the buildout condition. Due to the fact that much of the City will continue to lie within the FID that future conditions will be similar to historic conditions and that on average the City will continue to have adequate surface water supplies. It should also be recognized that the past two years have resulted in significant deviations from the norm and should climate change be realized, there could be significant deviation realized than the historical record. For these reasons it is highly recommended that the City for reliability purposes discuss the following topics with FID:

1. Purchase of additional surface water supplies in dry years. Current data suggests additional supplies are not needed at the present; however, at the General Plan buildout (2085), as much as 23,000 acre-feet is needed in water years less than 50 percent of normal and up to 32,000 acre-feet is needed when a water year is less than 25 percent of normal.
2. Make additional surface water supply available to the City that does not have any place of use restrictions. Estimated volume of supply needed at buildout is 5,800 acre-feet.
3. Allow for continual use of canal system year round (utilize the canal for intentional recharge)
4. Allow for delivery of water from the Friant-Kern Canal

5. Allow the City to acquire FID abandoned facilities for either recycled or recharge water

It is reasonable to anticipate that the City and FID could either renegotiate the Conveyance Agreement or develop a new agreement. **Table 7.4-1** provides a summary of these supplies for the Sphere of Influence buildout condition.

As mentioned previously, the Garfield Water District and International Water District are within the General Plan boundaries. Approximately 50% of the GWD is within the Plan area, and all of the IWD is within the Plan area. The supplies associated with each district are shown in **Table 7.4-2**. The availability and reliability of these surface water supplies vary by contract conditions as well as hydrologic conditions. This plan assumes that these supplies will be acquired as the property is developed. Should that not be the case then other supplies will need to be acquired. The reliability of these water supplies are examined and summarized in Chapter 9 Water Supply Reliability.

Table 7.4-1: Estimated Water Supplies at 2035 for Buildout of the Sphere of Influence

	Clovis Area	Northwest Village	Northeast Triangle	Loma Vista	Northeast Village	Urban Area Subtotal	Northeast Corner	Northern Rural	Between Canal	Southeast Corner	Total
Area (acres)											
Total Area	13,510	2,630	1,650	3,310	1,040	22,100	-	-	-	-	22,100
Area w/in FID	12,835	1,430	-	3,310	-	17,600	-	-	-	-	17,600
Annexed Area w/ in FID (Developed Ag)	-	-	390	-	-	400	-	-	-	-	400
Area w/in Garfield Water District	-	810	-	-	-	800	-	-	-	-	800
Area w/in International Water District	-	-	-	-	880	900	-	-	-	-	900
Surface Water Supply (acre-feet)											
Kings River Entitlement[1]	27,030	3,010	-	6,970	-	37,000	-	-	-	-	37,000
Class II – FID[2]	930	100	-	240	-	1,300	-	-	-	-	1,300
Water to FID Annexed Lands[3]	-	-	70	-	-	100	-	-	-	-	100
Garfield Water District[4]	-	1,650	-	-	-	1,700	-	-	-	-	1,700
International Water District	-	-	-	-	1,020	1,000	-	-	-	-	1,000
Surface Water Subtotal	***28,000***	***4,800***	***100***	***7,200***	***1,000***	***41,100***	-	-	-	-	***41,100***
Other Water Supply (acre-feet)											
Recycled Water	1,800	450	350	1,850	50	4,500	-	-	-	-	4,500
Effluent Exchange	-	-	-	-	-	-	-	-	-	-	-
Fresno Stream Group	-	-	-	-	-	-	-	-	-	-	-
Other Water Subtotal	***1,800***	***450***	***350***	***1,850***	***100***	***4,500***	-	-	-	-	***4,500***
Groundwater Banking Facilities (acre-feet)											
Waldron Pond	-	-	-	-	-	-	-	-	-	-	-
Boswell Facility	-	-	4,500	-	-	4,500	-	-	-	-	4,500
Groundwater Banking Subtotal	-	-	***4,500***	-	-	***4,500***	-	-	-	-	***4,500***
					Total Water Supply	***50,100***					***50,100***

Notes:
1. FID encompasses approximately 245,300 acres and provides water to about 201,400 acres. From 1985 to 2015, estimated annual Kings River entitlement was approximately 424,200 acre-feet or 2.11 acre-feet per acre.
2. Class 2 water from the Central Valley Project (CVP) is highly variable with zero allocations possible. From 1985 to 2015, Class 2 deliveries averaged about 15,000 acre-feet, which equates to a yield of 0.07 acre-feet per acre. FID's contract amount is 75,000 acre-feet, only available during a 100% declaration, or 0.31 acre-feet per acre. However, due to the San Joaquin River Restoration Act, approximately forty percent of this supply will be available or 0.12 acre-feet per acre.
3. FID water deliveries to annexed lands were based upon a historic average entitlement of 200 acre-feet per year or 0.17 acre-feet per acre.
4. CVP Class 1 entitlements for Garfield Water District and International Water District are 3,500 acre-feet and 1,200 acre-feet, respectively, with actually deliveries equal to approximately 94% of the contract amount. Since Clovis' planning area only encompasses about half of the Garfield Water District available supply was reduced by 50%. Preliminary analyses of the impact of the San Joaquin River Restoration program on the Friant system suggest that supplies may be reduced by up to 74% of the contract supply.
5. All subtotal and totals were rounded to the nearest hundred.
6. Supplies shown in this table reflects average conditions developed form historical delivery records. Utilization of these supplies requires capital projects and revised new agreements with FID.
7. Waldron Pond is a dry year supply so it was excluded from the subtotal.
8. No values were shown for Effluent Exchange or the Fresno Stream Group since agreements / applications have not been executed.
9. Utilization of recycled water depends on treatment capacity and number of users plumbed to received this water. Clovis has the potential to provide up to 5,000 acre-feet per year of recycled water in lieu of potable water.

Table 7.4-2: Estimated Water Supplies at 2035 for Buildout of General Plan

	Clovis Area	Northwest Village	Northeast Triangle	Loma Vista	Northeast Village	Urban Area Subtotal	Northern Rural	Northeast Corner	Between Canal	Southeast Corner	Total
Area (acres)											
Total Area	13,510	2,630	2,080	3,310	9,030	30,600	1,830	3,000	7,490	4,640	47,600
Area w/in FID	12,835	1,430	-	3,310	-	17,600	-	-	550	4,640	22,800
Annexed Area w/ in FID (Developed Ag)	-	-	390	-	500	900	-	-	220	-	1,100
Area w/in Garfield Water District	-	810	-	-	-	800	-	-	-	-	800
Area w/in International Water District	-	-	-	-	720	700	-	-	-	-	700
Surface Water Supply (acre-feet)											
Kings River Entitlement[1]	27,030	3,010	-	6,970	-	37,000	-	-	1,160	9,770	47,900
Class II – FID[2]	930	100	-	240	-	1,300	-	-	40	340	1,700
Water to FID Annexed Lands[3]	-	-	70	-	90	200	-	-	40	-	200
Garfield Water District[4]	-	1,650	-	-	-	1,700	100	-	-	-	1,800
International Water District	-	-	-	-	1,200	1,200	-	-	-	-	1,200
Surface Water Subtotal	**28,000**	**4,800**	**100**	**7,200**	**1,300**	**41,400**	**100**	**-**	**1,200**	**10,100**	**52,800**
Other Water Supply (acre-feet)											
Recycled Water	1,800	450	350	1,850	50	4,500	-	-	-	-	4,500
Effluent Exchange	-	-	-	-	-	-	-	-	-	-	-
Fresno Stream Group	-	-	-	-	-	-	-	-	-	-	-
Other Water Subtotal	**1,800**	**450**	**350**	**1,850**	**50**	**4,500**	**-**	**-**	**-**	**-**	**4,500**
Groundwater Banking Facilities (acre-feet)											
Waldron Pond	-	-	-	-	-	-	-	-	-	-	-
Boswell Facility	-	-	4,500	-	-	4,500	-	-	-	-	4,500
Groundwater Banking Subtotal	**-**	**-**	**4,500**	**-**	**-**	**4,500**	**-**	**-**	**-**	**-**	**4,500**
Total Surface Supply						**50,400**					**61,800**

Notes:
1. FID encompasses approximately 245,300 acres and provides water to about 201,400 acres. From 1985 to 2015, estimated annual Kings River entitlement was approximately 424,200 acre-feet or 2.11 acre-feet per acre.
2. Class 2 water from the Central Valley Project (CVP) is highly variable with zero allocations possible. From 1985 to 2015, Class 2 deliveries averaged about 15,000 acre-feet, which equates to a yield of 0.07 acre-feet per acre. FID's contract amount is 75,000 acre-feet, only available during a 100% declaration, or 0.31 acre-feet per acre. However, due to the San Joaquin River Restoration Act, approximately forty percent of this supply will be available or 0.12 acre-feet per acre.
3. FID water deliveries to annexed lands were based upon a historic average entitlement of 200 acre-feet per year or 0.17 acre-feet per acre.
4. CVP Class 1 entitlements for Garfield Water District and International Water District are 3,500 acre-feet and 1,200 acre-feet, respectively, with actually deliveries equal to approximately 94% of the contract amount. Since Clovis' planning area only encompasses about half of the Garfield Water District available supply was reduced by 50%. Preliminary analyses of the impact of the San Joaquin River Restoration program on the Friant system suggest that supplies may be reduced by up to 74% of the contract supply.
5. All subtotal and totals were rounded to the nearest hundred.
6. Supplies shown in this table reflect average conditions developed form historical delivery records. Utilization of these supplies requires capital projects and revised new agreements with FID.
7. Waldron Pond is a dry year supply so it was excluded from the subtotal.
8. No values were shown for Effluent Exchange or the Fresno Stream Group since agreements / applications have not been executed.
9. Surface water supplies for unserved areas are not available for City use; FID, GWD and IWD supplies are shown for reference but for the Northern Rural, Northeast Corner, Between Canals, and Southeast Corner villages but are not used in the later reconciliation.
10. Utilization of recycled water depends on treatment capacity and number of users plumbed to received this water. Clovis has the potential to provide up to 5,000 acre-feet per year of recycled water in lieu of potable water.

7.5 Summary

In summary, surface supplies are available to a large part of the study area. It is important they be utilized as the land use changes from irrigated agriculture to urban uses. The most significant water supplies are within the Fresno Irrigation District, and the Kings River entitlement consists of over 90 percent of total surface supplies. Kings River water is not allowed outside the Kings River Water Association boundaries which may cause some problems with the supply of water to the Northeast Village. Full utilization of Bureau water supplies augmented with water transfer and/or groundwater banking will most likely be required to provide a dependable water supply to this village.

Historical surface water deliveries to the study area have approximated the water supply available to the area. During the same period of time overdraft has occurred, suggesting that full utilization of the surface water supplies will be imperative as development occurs to avoid exacerbating the overdraft condition.

The surface water supplies are of excellent chemical quality. More turbid water could be expected from the stream group than other surface sources relegating them to an alternate water source during times when turbidity is excessive. Turbidity caused by local stream runoff has caused some issues and timing with surface water treatment. Identification of means other than shutting the surface water treatment plant down during the events should be evaluated.

8 Recycled Water Supplies

The following chapter provides a review and quantification of recycle water supplies which may meet a portion of existing and future potable water demands within the City's service area. Clovis constructed a Sewage Treatment/Water Reuse Facility (Reuse Facility, ST/WRF) in 2008, which began operation in 2009. The Reuse Facility is located north of Ashlan Avenue between Thompson and McCall Avenues and was constructed to handle 2.8 million gallons per day (MGD) in its first phase with an ultimate treatment capacity of 8.4 MGD. Recycled water produced by the Reuse Facility complies with Title 22 standards (California Code of Regulations) and permitted application includes many unrestricted uses such as irrigation, impounding, cooling, and commercial/industrial applications. Currently, primary recycled water use is in landscaped areas adjacent to the recycled water transmission main.

8.1 Assumption and Limitations

Several assumptions were made in development and evaluation of potential recycled water users within Clovis; if any of these assumptions are modified, recommendations contained herein may need to be updated as well. Below is a list of assumptions and limitations that were instrumental in the development of this chapter:

- Probable future demands are an estimate of actual future demands.
- Use of recycled water is and will be constrained by the daily production of the ST/WRF since it is the only source and the amount of water needed to match irrigation demand of landscaped areas.
- Some potential recycled water users may not use recycled water because of the economics associated with high capital improvement cost and low volumetric use.
- Retrofitting of existing plumbing systems may reduce the willingness of some users to participate in the recycled water program.
- Landscape irrigation is, and will likely continue to be, the largest use of recycled water.

8.2 Recycle Water Supplies

Phase 1 of the ST/WRF was designed for an average daily flow of 2.8 million gallons per day (MGD), equating to an annual average treatment capacity of about 3,100 AFY. Although this is the maximum amount of recycled water available for Phase 1, current production is slightly below anticipated planned flow rate, therefore, Phase 2 (2025) and Phase 3 (2030) facility expansions will not occur until increased capacity is required.

Table 8.2-1: ST/WRF Treatment Capacity

Phase	Startup	Treatment Capacity		
		Average Day (MGD)	Average Day (cfs)	Annual Average (AF)
1	2008	2.8	4.3	3,100
3	2025-2030	5.6	8.7	6.300
5	2035-2040	8.4	13.0	9,400

Note:
1. Startup dates are estimated based on the sewage treatment needs of Clovis.

In 2015, the ST/WRF generated about 1,870 acre-feet with existing customers using nearly 396 acre-feet and the remainder1m474 acre-feet, discharged to Fancher Creek.

8.3 Demands

Areas with the greatest potential for recycled water use include users within the following regions: a ¾-mile buffer of the existing recycled water transmission main, Northeast Triangle, Northwest Village, and Loma Vista. **Figure 8.3-1** identifies specific uses within these various regions and shows the infrastructure needed to deliver the recycled water.

It is critical to evaluate the ability of the ST/WRF to meet recycle water demand on a consistent basis annually. Recycled water demand has an inherit variability controlled by its end use that must be considered as part of a master planning process. Systems where outdoor landscaping is the primary use of recycled water, such as Clovis follow a pattern similar to an evapotranspiration (ET) rate for grass, with the highest demand months being July, generally. **Figure 8.3-2**Figure 3.2-1 shows the monthly variability in recycled water use for these customers along with monthly ET for grass.

Figure 8.3-1: Recycled Water Users and Infrastructure

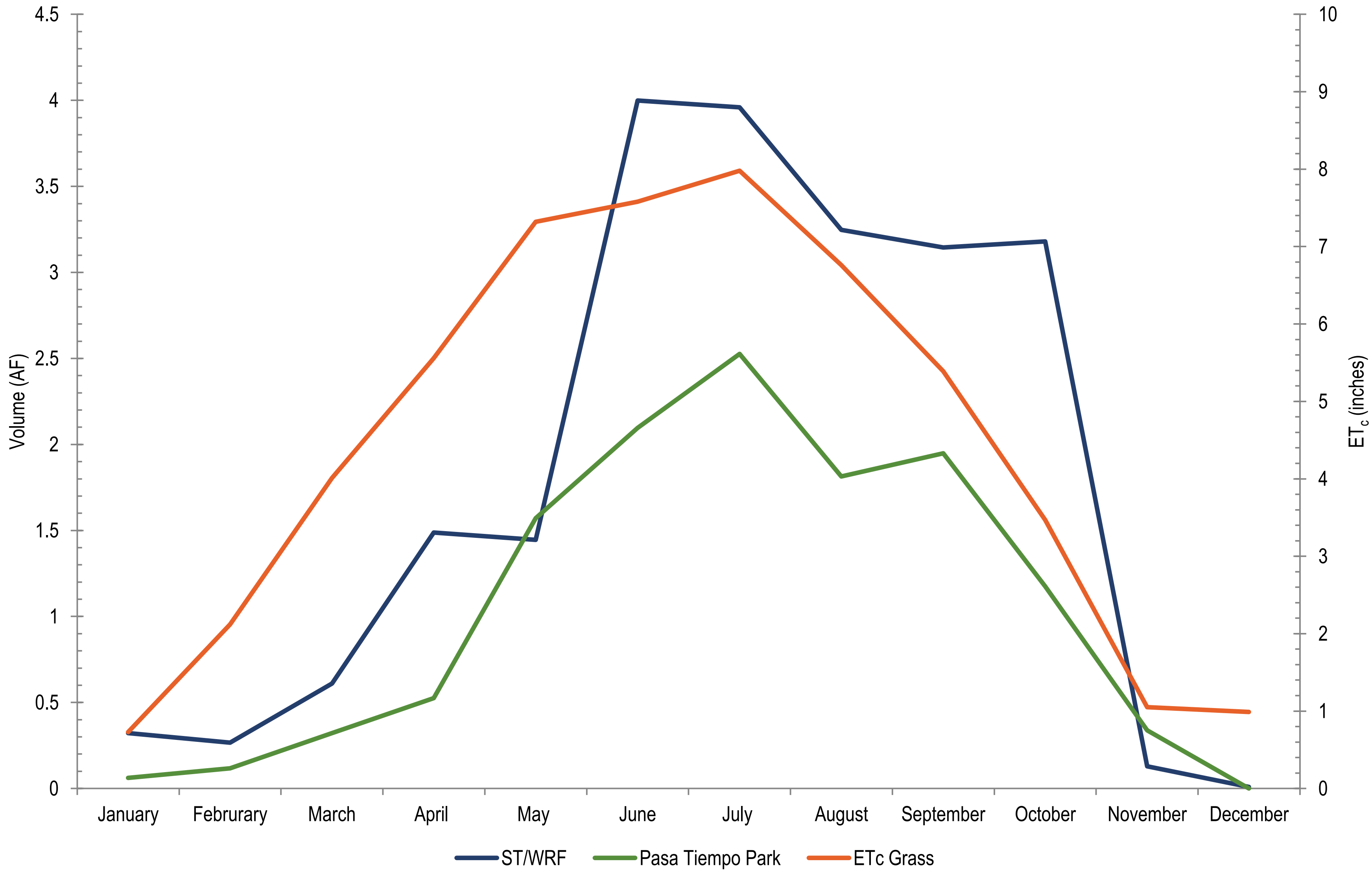


Figure 8.3-2: Comparison of Monthly Recycled Water Use to Typical Evapotranspiration for Grass

8.4 Offsetting Potable Water Use

Assuming that all users employ recycle water supplies for landscape irrigation the total demand will follow the water requirements due to evapotranspiration rates, with high demands in the summer and low demands in the winter. Based on this assumption, the total annual service area demand and potable water offset potential is limited to the area for which the plant capacity may supply the maximum demand month for landscape irrigation, July. Under these assumptions, the analysis in **Table 8.4-1** indicates the maximum acreage that can be served annually with reliable recycle water deliveries is 370 acres with current supplies up to nearly 1,700 acres in at buildout of the ST/WRF.

Table 8.4-1: Potential Recycled Water Use Evaluation by Service Area

Phase	Period	ST/WRF Capacity Estimate	ST/WRF Max Service Area-July Demands[1] (acres)
1	2015 to 2020	2,100 AFY	370
2	2020 to 2025	3,100 AFY	560
3	2025 to 2030	5,500 AFY	970
4	2030 to 2035	6,300 AFY	1,110
5	2045 to Buildout	9,400 AFY	1,670

Note:
1. Calculated using a landscape irrigation unit demand of 0.48 acre-feet for the month of July and July production by the ST/WRF.

As such, annually there is excess recycled water produced in the winter above the demands of landscape. This excess annual recycled water would be available for discharge to facilities such as Marion Recharge to benefit groundwater sustainability efforts and allow an additional beneficial use for recycled water. An evaluation of annual plant capacity of recycled water, service area demand, excess recycled water to Marion Recharge, and the remaining recycled water to the Fancher Creek outfall is presented in **Table 8.4-2.**

Table 8.4-2: Potential Recycled Water Use Evaluation by Service Area

Phase	Period	ST/WRF Capacity Estimate (AF/yr)	ST/WRF Service Area Demand (AF/yr)	Excess RW to Marion Recharge (AF/yr)[1]	Excess RW to Outfall (AF/yr)
1	2015 to 2020	2,100	1,400	-	700
2	2020 to 2025	3,100	1,600	1,500	-
3	2025 to 2030	5,500	3,100	2,000	400
4	2030 to 2035	6,300	10,300	2,700	-
5	2045 to Buildout	9,400	10,300	2,700	-

Notes:
1. Maximum deliveries to Marion Recharge defined as the available capacity above average Kings River deliveries, about 2,700 AF
2. Values in the ST/WRF Service Area Demand column represent the amount of potable water demand potentially offset by using recycled water, which is constrained by daily production.

9 Water Supply Reliability

The purpose of this chapter is to develop an understanding of the various sources of supply in the City's portfolio and to understand the reliability associated with these supplies. Within the various planning boundaries considered for this update to the water master plan, Clovis could potentially rely upon different combinations of the following supplies: 1) groundwater, 2) surface water (from Kings River, San Joaquin River, and local streams), and 3) recycled water. A more detailed discussion regarding the reliability of these sources is provided below.

9.1 Groundwater

As was discussed in Chapter 6, groundwater has been the predominate supply for Clovis. The groundwater basin is large and has tremendous storage capability, which is not subject to hydrologic variability associated with surface water supplies. In droughts, groundwater levels drop due to pumping and limited recharge and in wetter years more water is recharged causing groundwater levels to rise. With the addition of intentional recharge facilities, Clovis has been able to mimic the natural process and add more water to storage even in the more normal hydrologic periods.

More recently, there are two new constraints affecting this tremendous resource. The first is structural. As the City continues to grow it is predominantly to the Northeast and towards the foothills of the Sierra Nevada. Structurally the aquifer thins and the aquifer that the city has enjoyed becomes limited and in some instances nonexistent. In these areas, groundwater is not an option for a water source. Compounding this issue is the overall state of the California and specifically the Central Valley groundwater condition. In 2015, the State Legislature enacted the Sustainable Groundwater Management Act (SGMA), which, for the first time in the history of California, recognized that there are areas of the State where groundwater pumping is not sustainable. This is especially apparent in the Central Valley. As the regional groundwater levels decline many times the areas that see some of the greatest impacts are along the margins of the Central Valley, especially those lands that abut the edge of the foothills. This is the case with Clovis. As groundwater levels drop the aquifer thickness becomes less and the ability to pump groundwater lessens.

The second constraint that has the potential to impact reliability of groundwater supplies is water quality. In the Phase 1 report it was apparent that there were many different constituents that had impact on where wells could be located and how they should be constructed to limit the production of supplies that had levels that exceed the state limit on drinking water. Since 1995, the same constituents are of concern, but especially with DBCP. Clovis has been able to lessen the number of wells that are needed to produce water with treatment. A new constituent, 1,2,3-Trichloropropane (TCP), has emerged as a concern and it is expected that up to 10 wells may be effected and require treatment to allow for the continued use.

9.2 Surface Water

Surface water supplies are based upon hydrologic conditions which are highly variable. When considering the use and acquisition of surface water supplies, a key issue that must be addressed is the reliability of the water source. Evaluations of critical dry and multi-year dry periods must be included to satisfy recent State laws. Chapter 7 described the basic resource.

Since 2004, when the City's surface water treatment plant came online, Clovis has produced about 6,900 AF of treated surface water annually, which accounts for about 27% of the City's average annual water demand of 25,800 AF for this time period. The City of Clovis currently has access to Kings River through agreements with the Fresno Irrigation District, and as the City continues to grow to the north and northeast, opportunities will become available to access United States Bureau of Reclamation Central Valley Project water from nearby agricultural water districts.

9.2.1 Kings River – Fresno Irrigation District

Stated again, Fresno Irrigation District holds "low flow" rights to the Kings River. While the District is entitled to water at nearly all flows, the percentage of total flow FID may divert is higher at relatively low Kings River flows. Therefore, for a given percent water year, FID receives a greater entitlement if the snow pack melts slowly than if the runoff occurs rapidly.

Between 1985 and 2015, Fresno Irrigation District has received an average annual entitlement from the Kings River of about 424,200 AF (see **Figure 7.2-1**). The median entitlement (the minimum amount received in the half of the years with the highest entitlements or the maximum amount received in the half of the years with the lowest entitlements) is 414,400 AF. An annual entitlement of 310,600 AF has occurred or exceeded in eighty percent (80%) of the years of record.

The District's annual entitlement can vary widely for similar type water years. The widest scatter generally occurs around water years that are about sixty percent (60%) of the historical mean where yields varied from 312,000 to 412,000 AF. The primary reason for this wide range of entitlement is the variability in precipitation and snowmelt.

As stated previously, FID gains entitlement on the Kings River based upon an entitlement table and in turns makes a pro rata share of these supplies available to Clovis. See Conveyance Agreement for additional details about water supply available to Clovis. **Figure 9.2-2** shows the projected supply that would be available to Clovis, based upon the percentage of land within the FID, for the urban villages and the General Plan area. At buildout of land within FID, the Urban Area would have access, on average, to about 36,600 acre-feet with over 26,800 acre-feet available eighty percent (80%) of the time.

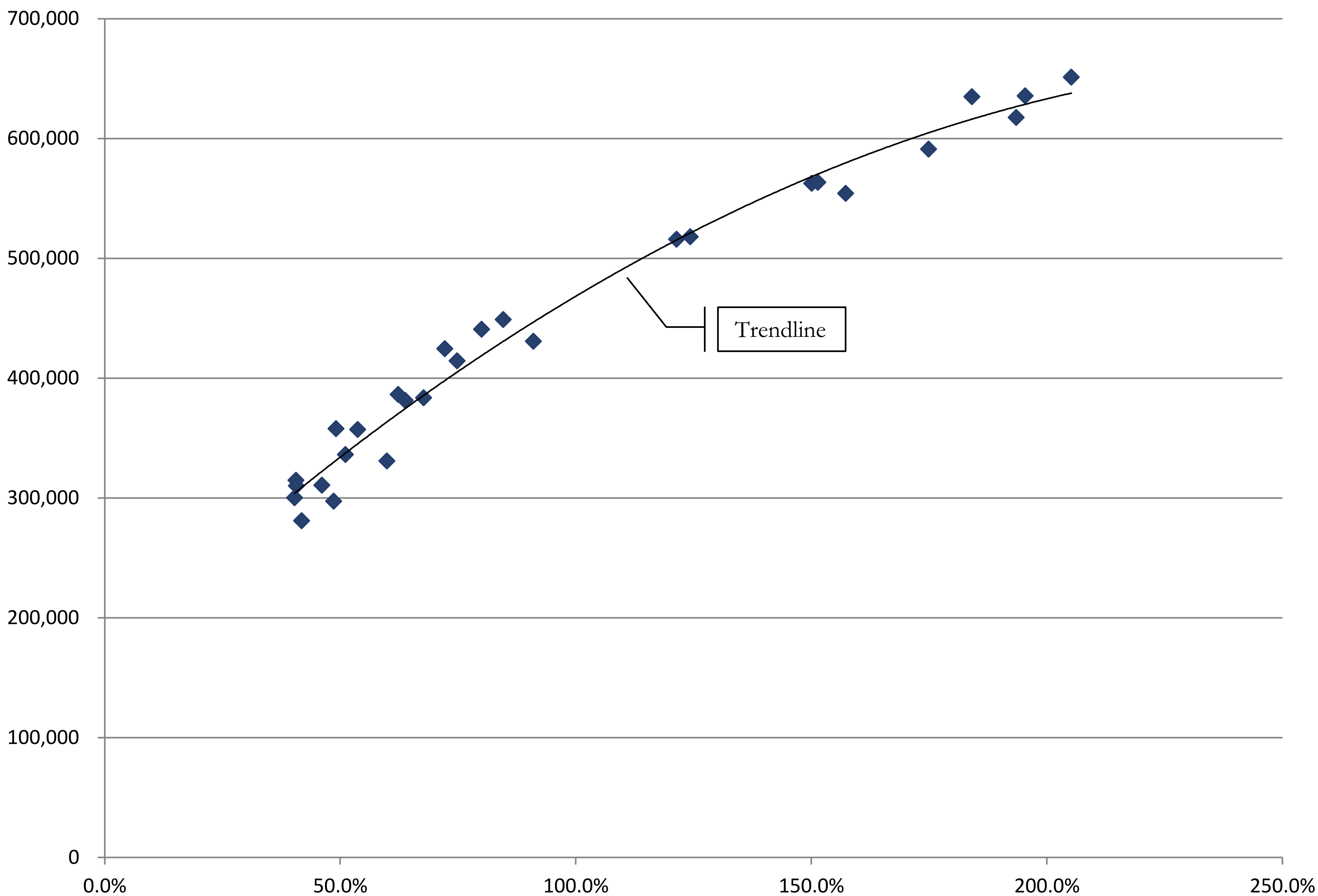


Figure 9.2-1: Historic Kings River Entitlement for FID by Percent Water Year

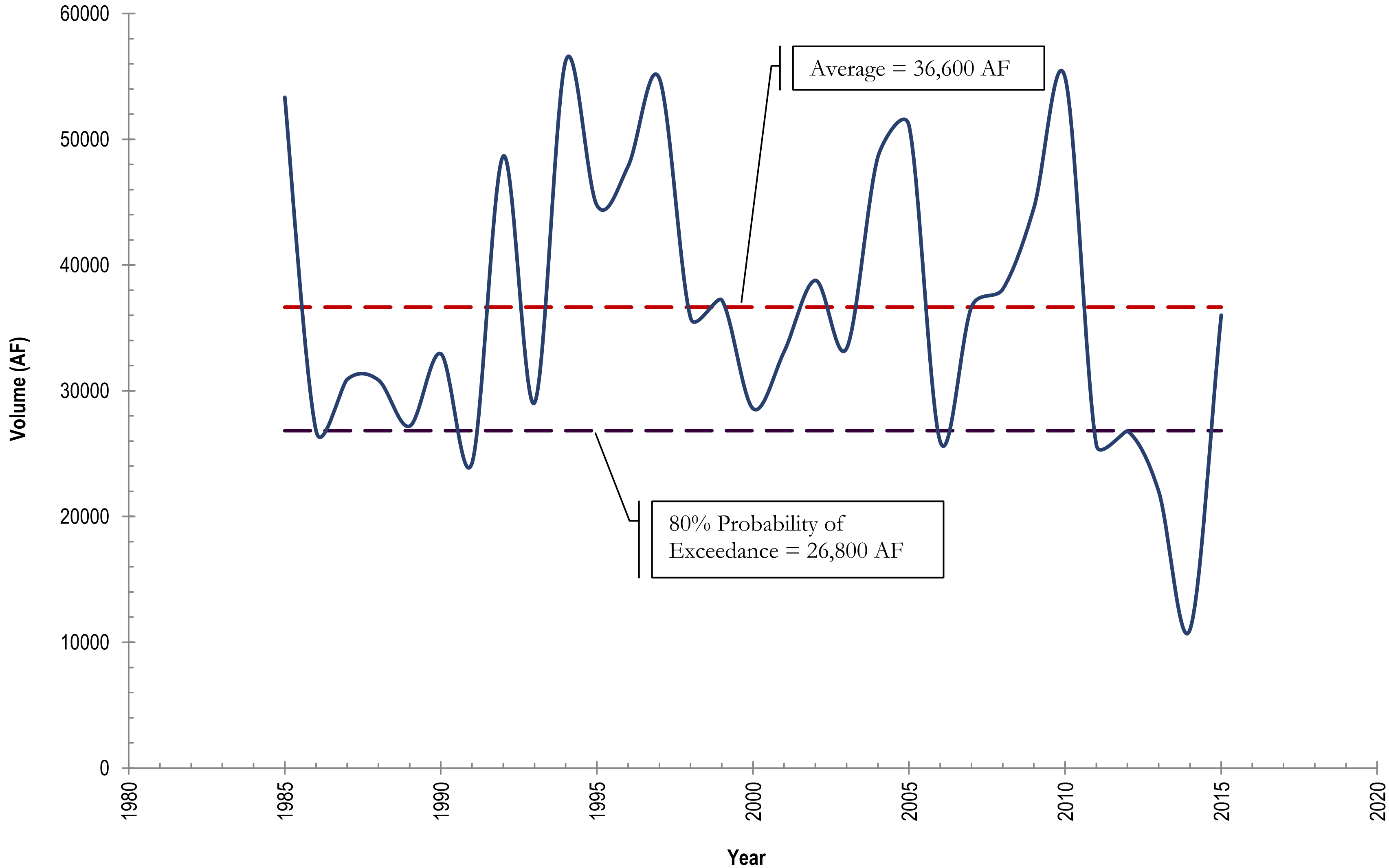


Figure 9.2-2: Estimate of Kings River Entitlement Available to Clovis at Buildout of Urban Villages

9.2.2 Central Valley Project – Friant Division

The Central Valley Project (CVP) and especially the San Joaquin River has seen an unprecedented drought in recent years and with the San Joaquin River Settlement[14] it is very difficult to predict future supply based upon the history. As an example in the previous fifty (50) years of record, the smallest allocation of supply was twenty-five percent (25%) in 1977, which was the driest year of record and served as the baseline for a worst-case scenario. Although the past two years, 2014 and 2015, were not as dry as in 1977, allocation from the Friant Division of the CVP was still zero percent (0%). This is in part due to San Joaquin River Settlement, which dedicated about 170,000 AF of water in a normal year to support river restoration as well as commitments to the exchange contractors to supply surface water that cannot be delivered from Lake Shasta due to pumping restrictions in the Bay Delta. Recent estimates suggest the potential for allocations to be about thirty-five percent (35%) of historical values for similar hydrologic conditions.

9.2.3 Fresno Streams Group

The streams group is a local surface water supply source, and as such there is local control and the entities described previously have the control to direct this supply where they wish within the operating parameters of the Fresno Metropolitan Flood Control District (FMFCD or Flood Control). Presently much of this supply is regulated within the flood control facilities and reregulated into FID's conveyance and distribution system. Much of the time these supplies are routed to intentional recharge and banking facilities and captured within the water balance of the regional area. However, Big Dry Creek Reservoir has the ability to experience a tremendous flow volume compared to the other systems and as such has much more regulated flood space. Flood Control relies on operational methodology for the dam from the U.S Army Corp of Engineering (USACE), which requires under certain conditions releasing flood flows to an auxiliary spillway that diverts flows into Little Dry Creek and thence to the San Joaquin River. These flows are based upon rainfall and thus the variance is based upon the hydrological year type. Thus, the variability is very similar to the Kings River flows described above but even more erratic because they are truly based upon the hydrologic condition and not a diversion schedule of a Kings River.

9.3 Groundwater Banking Facilities

Groundwater banks by their nature are a facility that have been developed to take highly variable flood water and convert that variable frequency and make it dependable. Thus the purpose is to develop, in the water world, a dependable dry year supply. In the case of the banks operated by FID, there is access to significant quantities of flood water, available land for intentional recharge, and an agency (FID) with significant dry year supplies that pumps from the banking project and have the ability or duration of time to pump the supply into the agricultural system and allow for the transfer of surface supplies to Clovis. The factors that have the potential to negatively affect these projects are 1) not having rainfall and runoff so that water cannot be put

[14] San Joaquin River Settlement has two primary goals: 1) reestablishing a self-sustaining population of salmon and other fish below Friant Dam and 2) minimizing water supply impacts to farmers. In 2009, Congress authorized the San Joaquin River Restoration Act (Public Law 111-11) which implemented the settlement and authorized other planning activities and studies pertaining to river restoration.

into the facility and 2) being so dry that there is no opportunity to pump the groundwater into FID system and allow for the exchange and for Clovis to take a like amount from the FID system. The last two years were some of the driest on record. The Boswell bank in 2014 only recharged 2,000 AF rather than the expected 4,500 AF. In 2015, FID initially was not going to run irrigation deliveries but rather just provide for recharge within the canal system and at recharge ponds. If that had come to pass and the City had requested deliveries of supply from Waldron, the FID would have had to make deliveries from other supplies.

9.4 Recycled Water

By its nature recycle water supplies are available 365 days a year, 24 hours a day. To allow for some flexibility, storage is added to the system to dampen fluctuations on both the supply and demand sides but in general this supply needs a home constantly. It is the recommendation of this plan that this supply be first used within the master plan area and if possible used to offset demands that get met by pumping municipal wells. The constraint on this use is generally landscape demands in July or August. Over commitment of supplies could result in some areas not receiving the required supply and loss of vegetation. In the fall and winter months when irrigation demands are small a home needs to be found for the supply. More recently the State has been more proactive in the reuse of these supplies and has allowed for intentional recharge of these supplies. For Clovis, intentional recharge of supplies should be practiced which will allow for an increase of entitlement (or other surface water supplies) that can be used at the surface water treatment plant.

9.5 Reliability of Aggregated Supplies

Water supplies are typically analyzed under three (3) scenarios in order to estimate reliability. Key scenarios considered in this plan included 1) average annual, 2) critical dry, and 3) multi-dry years, which also corresponds to the same scenarios required by the state in other key urban water management planning documents. Of the supplies available to Clovis, only recycled water, banked water, and groundwater are independent of the hydrologic cycle with reliability primarily governed by facilities conveying those supplies. Surface water supplies such as those provided by the Kings River, San Joaquin River, and local streams are polar opposites with reliability correlating to hydrologic conditions. When quantifying average yield of those supplies a crucial fact is that all the water available would be fully utilized when available and if this were not so, then there would be a corresponding reduction in the long-term average yield.

9.5.1 Average Hydrologic Conditions

Table 9.5-1 reconciles water supplies and demands for each planning village within the General Plan. Within the five (5) villages planned for urbanization only three (3), Clovis, Northwest, and Loma Vista, have the potential for generating more supply than demand. Amongst the various urban villages the water supplies could potentially vary from a deficit of 17,900 Aft to a surplus of nearly 12,400 AF. The greatest potential for surplus water was within the Clovis village, a direct result of having the largest share of land within FID and only providing potable water for indoor use to an 860-acre rural residential area along Nees Avenue.

Overall, reconciliation of supplies and demands for the anticipated urbanized villages and the entire General Plan area revealed that Clovis has access to supplies, on an average basis, less than projected potable water demand. Within the urbanized villages there is an estimated 5,800 AF of deficit under average hydrologic conditions. In villages such as the Northeast where a significant portion of the gross area is not conterminous with FID, project demands would be nearly 10 times greater than supplies accessible to Clovis. So, balancing of supplies and demands within the urban village is predicated on utilizing all water available during wet periods of the hydrologic cycle and sustainable groundwater pumping so that underutilized supplies would be available to the other villages.

9.5.2 Place of Use Conditions

As stated earlier, the City of Clovis manages its water resources within the City boundary to provide for the long-term viability of maintaining its groundwater resources. To this end, the City's groundwater management plan has as its goal to stabilize groundwater levels so that the health of the system is maintained. To this end, surface water resources are used within the FID and groundwater is used to meet demands outside the FID. With the Jameson agreement with FID, the City established an ordinance to capture development fees to offset or pay for the development of surface supplies where land use development caused an increase in demands. **Table 9.5-2** identifies the current accounting for water supplies that have been developed by the City. The City will need to develop a policy as to how to proceed with development that is outside the FID. This may be to continue to invest in banking projects or water purchases to provide the surface water supply and reliability for these specific properties.

Table 9.5-1: Average Year Water Balance by Village at General Plan Buildout

Parameter	Volume (AF)										
	Clovis	Northwest Village	Northeast Triangle	Loma Vista	Northeast Village	Urban Area Subtotal	Northern Rural	Northeast Corner	Between Canal	Southeast Corner	Total
Supply											
Kings River	27,000	3,010	-	7,000	-	37,000	-	-	-	-	37,000
Groundwater (Sustainable Yield)	9,400	-	-	-	-	9,400	-	-	-	-	9,400
Exchange Water	-	-	-	-	-	-	-	-	-	-	-
Recycled Water	1,800	450	350	1,850	50	4,500	-	-	-	-	4,500
CVP Class I (GWD and IWD)	-	1,700	-	-	1,200	2,900	-	-	-	-	2,900
CVP Class II (FID)	930	100	-	240	-	1,300	-	-	-	-	1,300
Water to FID Annexed Lands	-	-	100	-	100	200	-	-	-	-	200
Waldron Pond	-	-	-	-	-	-	-	-	-	-	-
Boswell Bank	-	-	4,500	-	-	4,500	-	-	-	-	4,500
Supply Subtotal	***39,100***	***5,300***	***5,000***	***9,100***	***1,400***	***59,800***	***-***	***-***	***-***	***-***	***59,800***
Demand											
Baseline	26,700	7,000	4,700	7,700	19,300	65,400	-	-	-	-	65,400
Reconciliation											
Supply - Baseline	12,400	(1,700)	300	1,400	(17,900)	(5,500)	-	-	-	-	(5,500)
Additional Supplies											
Surface Water Supply Acquisition	3,800	1,700	-	-	-	-	-	-	-	-	-

Notes:
1. Values rounded to the nearest hundred.
2. Class 1 contracts from the Central Valley Project, have an average yield of 94 percent of the contract amount. However, once the San Joaquin River Restoration Program is fully implemented present day deliveries could be reduced by nearly 35 percent. Class 1 contracts for International and Garfield are 1,200 acre-feet and 1,875 acre-fee, respectively.
3. Exchange water set to zero since Clovis does not have an agreement for this water.
4. Water supplies from Waldron Bank were set to zero because the sources should not be needed for average hydrologic conditions.
5. Surface water supplies for unserved areas are not available for City use; FID, GWD and IWD supplies have been removed from the reconciliation for the Northern Rural, Northeast Corner, Between Canals, and Southeast Corner villages.
6. In order to have average water supplies available Clovis would need to utilize all the supply that is available in a wet year. If supplies are not fully utilized during wet periods of the hydrologic cycle then averages would be less than the values shown above.

9.5.3 Critical Dry and Multi-dry Hydrologic Conditions

For critical dry and multi-dry hydrologic conditions, reconciliation analyses considered three (3) different areas in order to show how values could change with growth. Areas of the greatest concern to Clovis included the following: entire sphere of influence[15], urbanized villages[16] within the General Plan area, and the entire General Plan area.

For the critical dry scenario, 2015 was used with a related 30 percent of normal entitlement. The reconciliation deficits could potentially vary from about 14,400 to 34,500 AF if baseline demands were used without any reduction for conservation. Assuming water conservation measures reduced demand by fifteen percent (15%) deficits could potentially vary from 7,700 to 24,700 AF. See **Table 9.5-2** for additional information associated with the critical dry year reconciliations.

The multiple dry year scenarios for the Kings River occurred in 2013, 2014, and 2015 (with annual water deliveries of 100 percent, 58 percent, and 30 percent of normal entitlement). The reconciliation deficits could range from 4,600 to 30,100 AF if baseline demands were used without any conservation and could vary from 5,500 to 23,600 AF if conservation is assumed. However, surpluses also exist depending on the year and buildout condition being evaluated. See **Table 9.5-3** for additional information associated with the multiple dry year reconciliations.

[15] Sphere of influence includes the Northwest Village, Clovis, and Loma Vista in their entirety along with that portion of the Northeast Triangle within boundaries formed by Shepherd Avenue, State Route 168, and the Enterprise Canal and a portion of the Northeast Village.

[16] Urbanized villages includes the following: Clovis, Northwest Village, Northeast Triangle, Loma Vista, and the Northeast Village.

Table 9.5-2: Critical Dry Year Water Balances for Various Planning Boundaries

Parameter	Volume (AF)	
	Sphere of Influence	Urban Areas (General Plan)
Supply		
Kings River	11,100	11,100
Groundwater (Sustainable Yield)	9,400	9,400
Exchange Water	-	-
Dual System	-	-
Recycled Water	4,500	4,500
CVP Class I	-	-
CVP Class II	-	-
Water to FID Annexed Lands	-	100
Waldron Pond	9,000	9,000
Boswell Bank	2,200	2,200
Supply Subtotal	***36,200***	***36,300***
Demand		
Baseline	45,000	65,400
Baseline w/ Conservation (15%)	38,300	55,600
Reconciliation		
Supply - Baseline	(8,800)	(29,100)
Supply – Baseline w/ Conservation (15%)	(2,100)	(19,300)
Additional Supplies		
Groundwater	2,100	19,300

Notes:
1. Values rounded to the nearest hundred.
2. Additional Supplies section identifies potential water sources needed to offset a shortfall in the Supply-Baseline w/ Conservation scenario.
3. Actual values may vary from the ones shown here because full utilization of these supplies depends on having capital facilities in place and operational.

Table 9.5-3: Multi-Dry Year Water Balance for Sphere of Influence and General Plan Boundaries

	SOI Volume (AFY)			Urban Areas (General Plan) (AFY)		
Parameter	**Year 1 (100%)**	**Year 2 (58%)**	**Year 3 (30%)**	**Year 1 (100%)**	**Year 2 (58%)**	**Year 3 (30%)**
Supply						
Kings River	37,000	20,400	11,100	37,000	21,500	11,000
Groundwater (Sustainable Yield)	9,400	9,400	9,400	9,400	9,400	9,400
Exchange Water	-	-	-	-	-	-
Dual System	-	-	-	-	-	-
Recycled Water	4,500	4,500	4,500	4,500	4,500	4,500
CVP Class I	2,700	-	-	2,900	-	-
CVP Class II	,1300	-	-	1,300	-	-
Water to FID Annexed Lands	100	100	-	200	100	100
Waldron Pond	9,000	9,000	9,000	9,000	9,000	9,000
Boswell Bank	1,000	2,200	1,300	1,000	2,200	1,300
Supply Subtotal	***65,000***	***46,700***	***35,300***	***65,300***	***46,700***	***35,400***
Demand						
Baseline	45,000	45,000	45,000	65,400	65,400	65,400
Baseline w/ Conservation (15%)	38,300	38,300	38,300	55,600	55,600	55,600
Reconciliation						
Supply – Baseline	20,000	1,700	(9,700)	(100)	(18,700)	(30,000)
Supply – Baseline w/ Conservation (15%)	26,700	8,400	(300)	9,700	(8,900)	(20,200)
Additional Supplies						
Groundwater	-	-	3,000	-	8,900	20,200

Notes:
1. Values rounded to the nearest hundred.
2. Additional Supplies section identified potential water sources needed to offset a shortfall in the Supply-Baseline with conservation scenario.
3. The driest multi year period for the Kings River since completion of Pine Flat Dam occurred from 2011 - 2013.
4. Exchange Water was not included in the water balance because Clovis does not have an agreement for this supply.

9.6 Summary

The existing groundwater basin has been a significant storage reservoir for the City. Intentional recharge efforts have contributed directly to the storage in the aquifer and the ability to pump more groundwater for the City. As the City continues to grow to the North, Northeast and East over areas that have a thinning aquifer and less groundwater supplies, the City will gradually become more reliant on surface supplies. Surface supplies are more variable. Storage will become more critical so that the reliability can be maintained. The following observations can be made:

For the SOI:

- Surface water supplies are adequate to meet estimated demands on an average year.
- Surface supplies are inadequate to meet demands on critical dry-year assuming that reclaimed and banked water is maximized without conservation that exceeds 15%.
- Surface supplies are adequate to meet multiple-year dry years one and two utilizing reclaimed water and banked water but would require greater conservation in year three.
- The City will need additional surface supplies to continue to develop lands outside the limits of FID, GID or IWD.

For Buildout:

- Surface supplies are inadequate by approximately 5,500 AF to meet demands on an average year; with conservation, surface supplies could be adequate to meet demands.
- Surface supplies are inadequate to meet demands in a critical dry year (for the Urban Area) by a range of approximately 19,300 to 29,100 AF. The range represents fifteen percent and no conservation, respectively.
- Surface supplies are adequate to meet year one of a multiple dry-year event with conservation but are inadequate from 100 to 30,000 AF to meet demand in a multi-year drought (for the Urban Area). The range represents all three years, with up to 15% conservation.

Figure 9.6-1 shows the anticipated supplies that could be available to the City at buildout of the SOI through 2035. A number of observations can be made:

- The City will rely on its contract with FID for surface supplies.
- Kings River surface supplies provide the majority of the water resources of the area.
- Conservation is critical in drought years.
- The Waldron bank or other groundwater supplies will be needed to meet demands.
- At buildout of the SOI, in a similar drought condition as the City experienced in 2015 the water supply shortage is approximately 3,000 AF with 15% conservation or 9,700 AF without conservation. This shortfall is shown being met through groundwater production. For reliability and financial purposes it might be advisable to develop an agreement for an additional water supply for those extreme conditions.

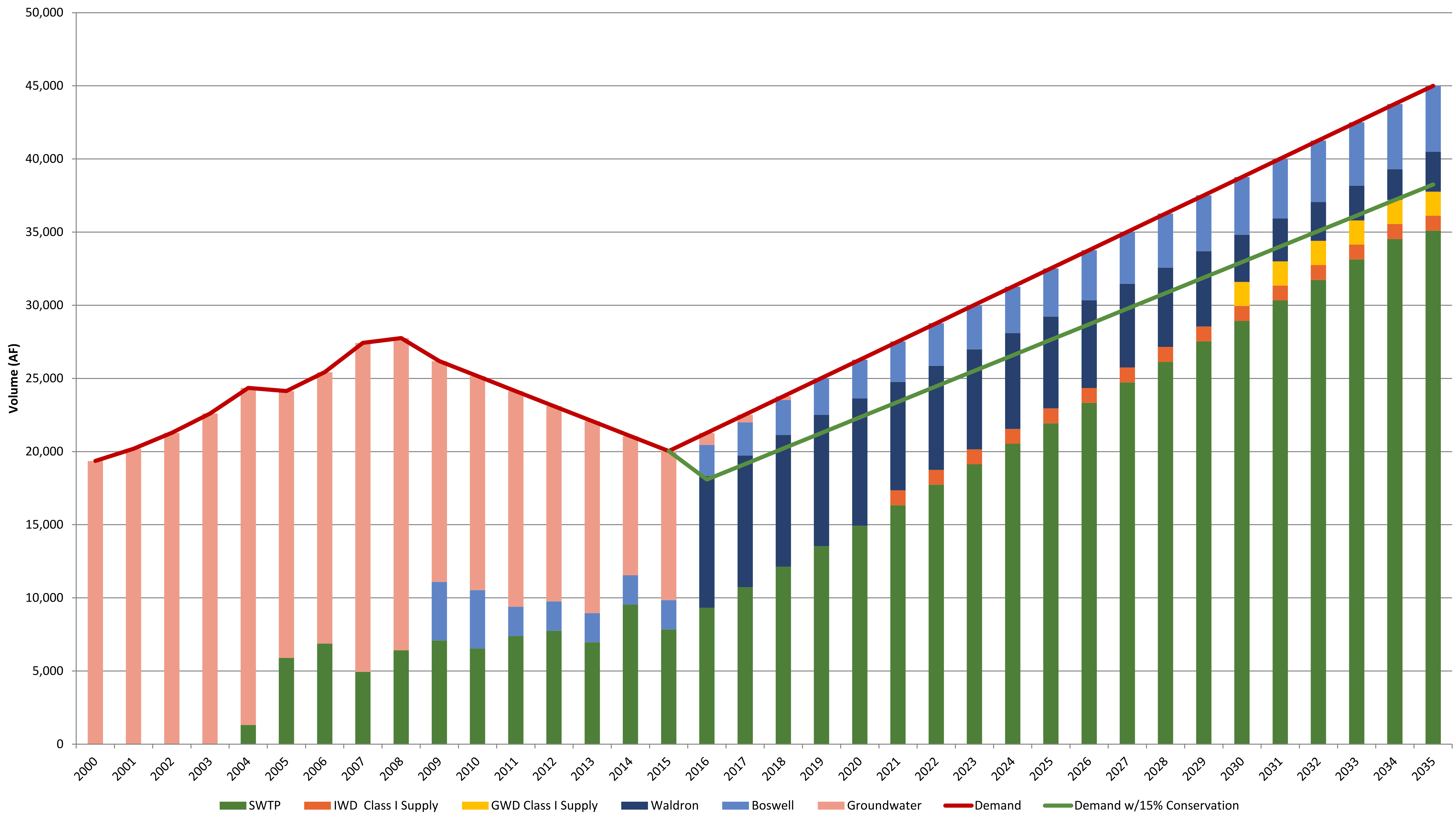


Figure 9.6-1: Evaluation of Supplies at Buildout of Urban Villages

10 Water Supply Plan

The purpose of this chapter is to discuss how the City of Clovis currently uses water supply sources to meet the needs of their users. This chapter also discusses two future conditions (buildout of the present sphere of influence boundary as well as buildout of the General Plan) and identifies surpluses or deficiencies in water supplies. Historic conditions for both supply and demand are discussed in earlier chapters and are not detailed in this discussion.

10.1 Comparison of Supply and Demands

10.1.1 Water Demands Summary

As discussed in Chapter 5, the water demands in the City's system have steadily increased as the City's population increased; however, the per capita demands of the customers have declined in recent years. A comparison is presented in Chapter 5 between projected water demands based on per capita demand factors and land use demand factors. For the purposes of this analysis, the land use demand factors are used to remove the fluctuations and unknown characteristics of population growth. **Table 9.5-1** summarizes the water demands for the City's system.

Table 10.1-1: Projected Water Demands

Village	Sphere of Influence Demands (2035)	Buildout Demands (2083)
Clovis	25,200	26,700
Northwest	6,500	7,000
Northeast Triangle	3,700	4,700
Loma Vista	5,600	7,700
Northeast Village	4,000	19,300
Northern Rural	-	-
Northeast Corner	-	-
Between Canals	-	-
Southeast Corner	-	-
Totals	**45,000**	**65,400**

Notes:
1. Totals have been rounded to nearest hundred acre-feet per year.
2. Buildout Demands include Urban Areas only, there are no demands associated with the remaining four villages.

10.1.2 Water Supply Summary

The City relies primarily on groundwater as a source of drinking water. The distribution system utilizes 35 active wells to extract water from the aquifer below the City. Since the construction of the City surface water treatment plant (SWTP) in 2004 the City has shifted its reliance on groundwater to a conjunctive use strategy where both groundwater and surface water are utilized to satisfy demands; the SWTP expansion in 2014 allowed the City to further reduce its reliance on groundwater. As discussed in Chapter 7, the City has agreements in place with several local water agencies to secure surface water. A large portion of water comes from the Kings River through an agreement with Fresno Irrigation District (FID). In addition, the City also has agreements in place to bank groundwater at two locations for use during dry climate periods and access to recycled water for use on landscaping. Recycled water helps to reduce demands on groundwater and surface water supplies. All three water supply sources will help offset groundwater pumping, therefore allowing the City to operate the water system in a sustainable manner. **Table 10.1-3** summarizes the projected water supplies by source and by village for the two planning horizons analyzed throughout the report.

Table 10.1-2: Projected Water Supply

Village	Pumped Ground Water Supply[1]		Surface Water Supply		Banked Groundwater Supply[2]		Recycled Water Supply[3]	
	SOI (2035)	Buildout (2083)	SOI (2035)	Buildout (2083)	SOI (2035)	Buildout (2083)	SOI (2035)	Buildout (2083)
Clovis	9,400	9,400	28,000	28,000	-	-	1,800	1,800
Northwest	-	-	4,800	4,800	-	-	450	450
Northeast Triangle	-	-	100	100	4,500	4,500	350	350
Loma Vista	-	-	7,200	7,200	-	-	1,850	1,850
Northeast Village	-	-	1,000	1,300	-	-	50	50
Northern Rural	-	-	-	-	-	-	-	-
Northeast Corner	-	-	-	-	-	-	-	-
Between Canals	-	-	-	-	-	-	-	-
Southeast Corner	-	-	-	-	-	-	-	-
Totals	**9,400**	**9,400**	**41,100**	**41,400**	**4,500**	**4,500**	**4,500**	**4,500**

Notes:
1. Pumped groundwater shown is estimated sustainable yield only. Actual pumping capacity is greater.
2. Volume shown is for the amount banked at the Bowell Facility. Waldron Pond banked water is for dry years only and excluded here.
3. Utilization of recycled water depends on treatment capacity and number of users. Clovis has the potential to provide up to 5,000 AFY of recycled water in lieu of potable water.
4. All values have been rounded to the nearest hundred acre-feet per year.

10.1.3 Reconciliation of Water Supply and Demand

Water demands and supplies were analyzed and summarized in the preceding sections of this chapter. An important part of a water supply plan is to reconcile water demands against the supplies. **Table 10.1-3** summarizes the reconciliation of the projected water demands against the projected supplies for both the 2035 General Plan update and the 2083 General Plan buildout boundaries. For the 2035 planning boundary, the City overall has more projected supply than demand; however, the same is not true for the 2083 planning boundary. It is worth noting that for both the 2035 and the 2083 planning boundaries the City has supply shortfalls for specific villages. The City may have to acquire additional supplies if those areas are to be built out as currently planned.

The other subject that needs to be addressed in this section relates to the planned change in operation of the City of Fresno Surface Water Treatment Plant. With the planned construction of the raw water pipeline from the Friant Kern Canal to the Fresno SWTP it can be expected that future operations of the Enterprise Canal may be limited to servicing the Clovis SWTP outside the normal operating patterns for agricultural deliveries. This has several possible ramifications. First, it can be expected that there may be higher seepage losses outside the study area boundary that will be attributed to the City. Secondly, the seepage losses that occur in the Enterprise Canal from year round operation and charged to the City of Fresno to the benefit of Clovis could be discontinued. It has been estimated that the volume could be as high as 2,000 af/year and it is recommended that the City of Clovis work with the FID on continuing the practice of flowing water through this system year round for the recharge benefits that will accrue to the City. The City of Fresno however may continue to utilize the Enterprise Canal during some periods to continue getting recharge benefit up-gradient from Fresno.

Table 10.1-3: Reconciliation of Water Supply and Demand

Village	SOI (2035)			Buildout (2083)		
	Total Demand	Total Supply	Difference	Total Demand	Total Supply	Difference
Clovis	25,200	39,200	14,000	26,700	39,200	12,500
Northwest	6,500	5,250	(1,250)	7,000	5,250	(1,750)
Northeast Triangle	3,700	4,950	1,250	4,700	4,950	250
Loma Vista	5,600	9,050	3,450	7,700	9,050	1,050
Northeast Village	4,000	1,050	(2,950)	19,300	1,350	(17,950)
Northern Rural	-	-	-	-	-	-
Northeast Corner	-	-	-	-	-	-
Between Canals	-	-	-	-	-	-
Southeast Corner	-	-	-	-	-	-
Totals	**45,000**	**59,500**	**14,500**	**65,400**	**59,800**	**(5,600)**

Notes:

1. All values have been rounded to nearest hundred acre-feet per year and may differ slightly from values noted previously due to rounding.

10.1.4 Reconciliation of Water Supply and Demand outside Fresno Irrigation District Service area

Within the City of Clovis' current water service area there are lands outside the service area of Fresno Irrigation District (FID) that are reliant upon water supplies from other than the Kings River. These consist of other surface supplies such as CVP supplies, local storm water, recycled water, groundwater, and water from banking facilities, depending on the type of water year. A significant banking project with Fresno Irrigation District is the Boswell Banking facility, which per agreement is estimated to be capable of yielding 4,500 acre-feet (AF) per year. According to 2013 water meter records from the City of Clovis (Clovis), the annual demand for existing city users[17], outside of FID's service area, was 2,113 AF. Using annual unit water demand factors developed for the current update of the Clovis Water Master Plan, annual demand for approved developments and future water use areas would be approximately1,450 AF and 2,550 AF, respectively. The cumulative demand for these user classifications is approximately 6,725 AF, inclusive of a 10 percent contingency. Excluding using pumped groundwater to this area from **Table 9.5-1** the total demand projected outside of the FID is approximately 11,000 AFY and 27,000 AFY at buildout of the SOI and General Plan, respectively.

10.2 Water Supply Goals

If the City is to complete the buildout of its General Plan it will have to take proactive measures to procure additional water supplies. The City should set goals for water supply planning purposes to use as benchmarks for progress, potentially including the following:

- Increase use of surface water supplies to reduce reliance on groundwater.
- Increase efforts to implement intentional recharge, including utilizing excess surface water supplies.
- Maintain existing recharge basins to maximize intentional recharge amounts.
- Pursue water supply agreements with International and Garfield Water Districts.
- Expand the use of recycled water within the City boundaries.
- Pursue additional groundwater banking opportunities.
- Continue to encourage conservation measures to reduce per capita demand.

10.3 Components of Future Water Supply

10.3.1 Groundwater

The City aims to reduce its groundwater consumption to the estimated sustainable yield of the aquifer. The City intends to expand its SWTP to provide surface water to meet water demands. With this expansion of the SWTP, the City will decrease its dependency on groundwater. Despite the reduction of reliance on groundwater, the City will still need to pump water from its wells at various times of the year. Groundwater

[17] Existing users include the downtown area, parcels with water meters in the Northeast Triangle, and landscaping along State Route 168.

pumping will persist into the future and will remain a necessity because the SWTP will have to be shut down from time to time in order for FID to perform maintenance on the Enterprise Canal.

10.3.2 Surface Water

From review of Chapter 9, it is evident that new development in Clovis is tied to treating surface water and the associated expansion of the SWTP. New water supplies and expansion of the SWTP will be required to serve developing areas.

Prior to 2004, Clovis relied solely on groundwater to meet their water demands for existing and future users. However, with the commissioning of the SWTP, Clovis' water balance has undergone a major change. Below is a list of issues potentially affecting sizing and operations of the SWTP.

- Decrease in the sustainable yield of the aquifer;
- Difficulty in providing sufficient recharge volume;
- Adding wellhead treatment (GAC vessels) to existing wells; or constructing new wells that require wellhead treatment;
- Change in per capita water use; and
- Reduced implementation of dual use and reclamation systems.

From a reliability standpoint, the City should pursue opportunities to operate the SWTP year round. It is recommended that investigations are initiated to evaluate delivery of surface water from the Friant Kern Canal.

As the City is built out, the boundaries will extend into nearby water districts, including Garfield and International Water Districts. The City should pursue agreements with these agencies in order secure water to support the planned development in these areas.

10.3.3 Recycled Water

The City is in the process of expanding its recycled water system. It should continue to expand this system to decrease potable water demands, specifically for outdoor landscaping. The City should look at opportunities to bring recycled water to landscaping in medians and other public areas. Issues that could potentially affect the expansion of the recycled water system are:

- Use of recycled water is and will be constrained by the daily production of the ST/WRF since it is the only source and the amount of water needed to match irrigation demand of landscaped areas.
- Some potential recycled water users may not use recycled water because of the economics associated with high capital improvement cost and low volumetric use.
- Retrofitting of existing plumbing systems may reduce the willingness of some users to participate in the recycled water program.
- Landscape irrigation is, and will likely continue to be, the largest use of recycled water.

The City should also seek out and evaluate opportunities to intentionally recharge surplus recycled water, especially in the winter months when irrigation demands are typically at their lowest.

10.3.4 Conservation

The City actively promotes water conservation measures. According to the 2015 Urban Water Management Plan (UWMP) Update the City has implemented the following conservation measures:

- Water waste prevention ordinance
- Water meters
- Conservation water pricing
- Public education and outreach
- Plumbing and toilet retrofit incentives
- Water surveys
- Commercial, industrial, and institutional conservation programs

It is envisioned that the City will continue to promote the above mentioned programs and also implement new programs in the future.

10.3.5 Groundwater Banking

The City should continue to bank water and also work with local agencies to identify new opportunities to bank water.

10.3.6 Water Supply Plan

Existing – The existing system is in good condition. From a water balance situation, groundwater levels continue to decline which indicates that overdraft continues. This could be a reflection of a regional condition but with rates of decline greater in the local area is thought to be a reflection of an in-balance in Clovis. Rates of decline have lessened with the initial construction of the SWTP and with expansion, there should be more opportunity to lessen groundwater pumping. Surface water supplies should be continued to be used first for intentional recharge and shortfalls in supplies for the SWTP should call on banked supplies to assure maximizing City facilities.

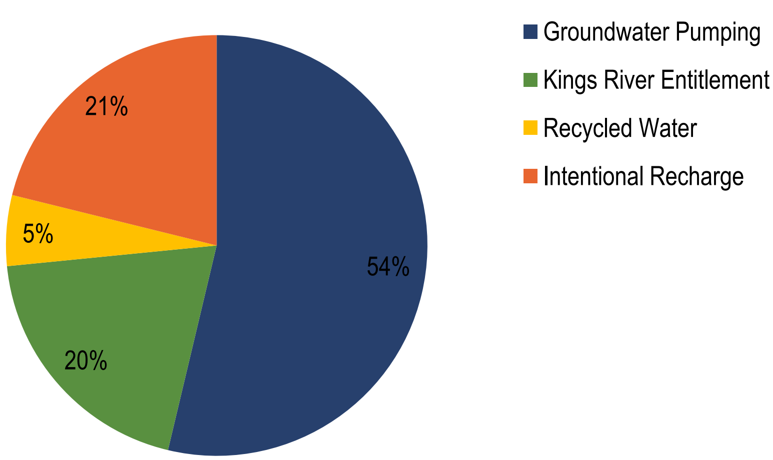


Figure 10.3-1: Existing Water Supplies

Sphere of Influence (SOI) – Development to the limits of the SOI is expected to continue the present course on development of surface supplies. Groundwater is planned to stay the same and additional supplies are planned to be served by construction of a second SWTP with capacity of approximately 20 MGD. If there are opportunities for expanded intentional recharge, they should be pursued.

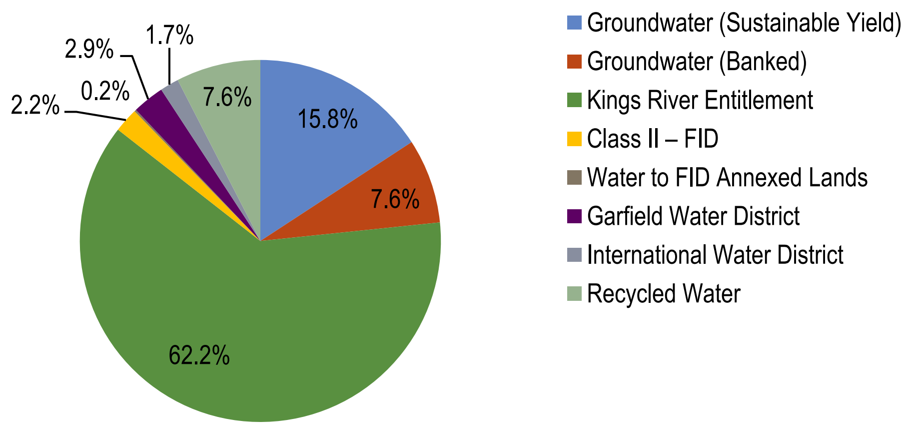


Figure 10.3-2: Sphere of Influence Water Supplies

General Plan Buildout – At buildout, the surface water requirements increase significantly. Much of the planned development outside the SOI is in an area with limited groundwater resources and will require the acquisition of surface water supplies. Since this area is outside organized irrigation and water district agencies, it will also be important to contract for surface supplies long before they are needed. Expansion of the surface water treatment facilities is estimated to total approximately 45 MGD.

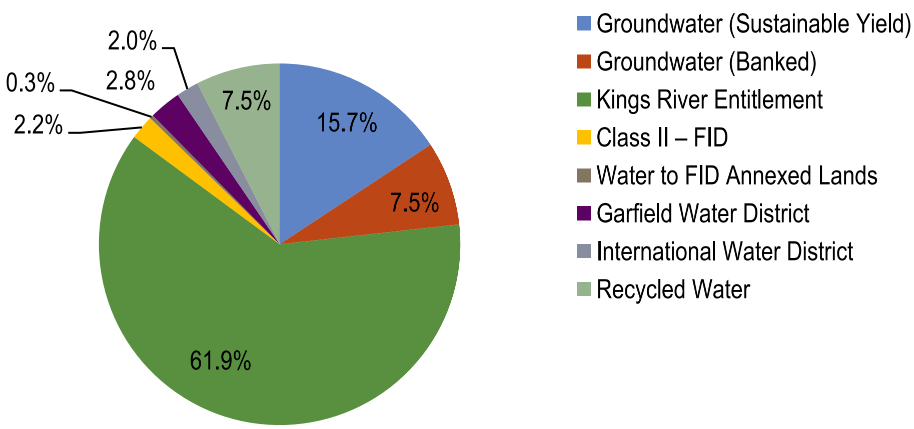


Figure 10.3-3: General Plan Buildout Water Supplies

The acquisition of new water supplies by Clovis will bring along many new water related issues. In order to effectively plan for the integration of these new water sources and the conditions associated with their use, it is expected Clovis will need to develop new policies. The polices will need to address acquisition of water sources, modification of existing water agreements/contracts, allocation of water supply "one-time" and annual costs, and modification of current groundwater management policies. All of these policies issues are discussed in detail below.

Issue 1: Water Supply Service Area

The most significant implementation issue facing Clovis in these new growth areas that lie outside FID boundaries, is the identification and acquisition of a water supply permitted for use in these regions.

Policy Options:

- Initiate discussions with FID about water sources permitted for use on land outside the Kings River service area.
- Increase surface water use through existing facilities.

Issue 2: Institutional Relationships with Water Purveyors

Clovis should develop working relationships with a number of other agencies that have water resources and responsibilities in the area.

Policy Options:

- Do nothing; wait until the need for increased water resources are imperative.
- Initiate negotiations and enter into contracts with the Garfield and International Water Districts for the allocation of water as lands are annexed to Clovis.
- Initiate negotiations with the City of Fresno and FID on the effluent exchange from the Regional Wastewater Treatment Facility.
- Initiate an agreement to purchase water supplies from the City of Fresno.
- Pursue a water rights permit from the SWRCB for storm water in Big Dry Creek.

Issue 3: Implement Paragraph 2, Part a, Subsection ii, of the City of Clovis/FID Water Banking and Reliability Agreement

Excerpt from banking agreement:

> In years when the projects annual yield is less than the amount required by the City, the District will acquire additional water supply from other sources to meet the City's needs and the City shall pay the actual cost for procuring such additional supply plus and administrative fee...

Policy Options:

- Execute this clause to acquire water when any land east of the Enterprise Canal is annexed to Clovis.
- Execute this clause to acquire water when any land is annexed that is not within FID, Garfield WD, or International WD.

Issue 4: Develop a cost allocation method for:

- Banking Agreement Contract Related to Payment of Operating Costs;
- FID/Clovis Water Banking and Reliability Agreement. Implementation of Paragraph 2, Part a; and
- Imported Water from Garfield and International Water Districts.

Policy Options:

- Initial costs should be accounted for as a part of the water enterprise fund account.
- Create benefit areas so that water purchase cost(s) are applied directly to the user associated with that purchase.
- Water cost is spread to all users; approximately $2M should be planned for annually.

Issue 5: Develop a Cost Allocation Method for New Purchases of Imported Water During Multiple Dry Year Periods from the Open Water Market

Policy Options:

- Cost is part of a drought surcharge and applies only to new planning areas sustained solely by surface water supplies.
- Drought surcharge is distributed to all existing water system users.

Issue 6: Consider / Resolve Limitations to the FID / Clovis Cooperative Supply Agreement

Policy Options:

- Negotiate contract amendment(s) with FID to improve Clovis' position for obtaining available water supplies.
- Accept existing clauses as is, and cost is part of a drought surcharge and applies only to new planning areas sustained solely by surface water supplies.

Issue 7: Consider / Resolve Limitations to the FID / Clovis Cooperative Delivery Agreement

Policy Options:

- Accept existing agreement as is.
- Negotiate a new contractual clause in this Section that would require FID to convey a supplemental supply of water through FID's facilities; if facilities are fully utilized, include provisions for FID, to the extent they are able, to find alternate conveyance facilities from other local water purveyors.

Issue 8: Reinforce and Improve Storm Water Basin Management Internal to Clovis

Increasing the amount of surface water recharged can only occur by adding recharge facilities, improving operation of existing Clovis recharge basins, or through improvement of the operations of FMFCD recharge basins.

Since FMFCD basins only recharge water, on average, 3 months out of the 4 to 11-month surface water delivery period, Clovis should attempt to negotiate expansion of the recharge capability of these facilities.

Policy Options:

- Negotiate a new agreement with FID and FMFCD for delivery of available water supplies to existing recharge basins after the rain season.
- Work with FMFCD to improve operations of existing recharge basins in an attempt to increase the recharge rate.
- Continue with existing management philosophy of basins.
- Negotiate a new contract or amendment to existing contract(s) requiring FMFCD to increase the water delivery period, assuming sufficient conveyance capacity is available.
- Expand or purchase additional acreage adjacent to basins to allow for operational flexibility.
- Initiate discussions with FMFCD for recharge within Big Dry Creek Reservoir.

Issue 9: Exchange Water from Wastewater Flows Delivered to the Fresno/Clovis Regional Wastewater Treatment Facility

Clovis' ability to obtain exchange water from FID for groundwater pumped from groundwater wells at the RWWTF is dependent on an agreement between the City of Fresno and FID; Clovis is not listed in this agreement. In order to firm up Clovis' right to use this water in the future, consider negotiating an amendment with FID to the conveyance agreement that includes provisions for making exchange water available to Clovis in the event Fresno or FID terminates their exchange water contract. Even though this supply has not been historically used by Clovis, this water source will prove invaluable during dry year(s) at buildout conditions, and it represents a water source that does not have hydrologic fluctuations like Kings River water or other surface water(s) available to Clovis.

Policy Options:

- Negotiate a new agreement or an amendment to the Clovis' conveyance agreement to include provisions that require FID to make exchange water available to Clovis even if the City of Fresno or FID terminates their exchange water contract.
- Do not negotiate changes to the exchange contract and deal with any consequence that may arise from termination of this contract when the time arises.
-

Issue 10: Develop a Firm Policy for Delivery of Potable Water to Rural Residential Users

In the 1999 WMP, water balance evaluations included provisions for delivery of potable water to rural residential properties at an annual rate of 0.5 feet per acre (ft/ac). As these land use types develop, we anticipate that these residents will request service connection to improve their water supply reliability and to receive some additional fire protection. Any users located outside the Kings River service area for FID must acquire a source of supply for the City.

Policy Options:

- Continue with current philosophy and do not provide any level of municipal service to these users until a critical condition is reached.
- Negotiate with the County of Fresno to provide some level of fire protection or other public service to these users. Users should pay their pro rata share of the level of public service provided by Clovis.
- Agree to provide potable water at the rate mentioned in the 1999 WMP and develop City policy to insure that sufficient constraints and restrictions are in place to maintain this rate.
- If Clovis agrees to service either potable or both potable and non-potable water needs of the rural residential users, city policy should require all neighborhoods to bring with them a source of supply to meet their annual needs during normal, critical dry and multi-year dry periods.
- The cost of providing full water service to these users can either be subsidized by existing users or recovered through a special rate program.

11 Water Distribution System Model

This chapter documents the development and purpose of the hydraulic model, the planning and design criteria used in evaluating the system, and existing and future system evaluations. The recommended system improvements resulting from the existing and future system evaluations are discussed in Chapter 12..

11.1 Introduction

This section introduces the purpose of the hydraulic model.

11.1.1 Purpose and Goals

The purpose of the hydraulic model development and evaluation is to provide a benchmarked planning tool for evaluating the existing infrastructure and projecting improvements to accommodate future growth. The goals for the model development and analysis were as follows:

- Provide a safe and reliable water supply to City residents and businesses
- Provide adequate levels of service for normal conditions and fire flow conditions
- Maximize the use of treated surface water
- Develop a GIS-based hydraulic model
- Calibrate the hydraulic model in an effort to provide a benchmark for evaluation
- Evaluate the existing system and propose improvements to accommodate future growth

11.1.2 Methodology

The hydraulic model was developed from the City's existing GIS records. The development of the hydraulic model was an iterative process. Following the GIS integration process, physical data on the following infrastructure were included in the model:

- Pipes: diameter, length, and Hazen-Williams roughness coefficient
- Pumps and Wells: head-flow curves, design points, SCADA controls, and elevation
- Tanks: Height, diameter, and elevation

After the development of the physical model, demands were allocated based on the City's meter records. The model was calibrated using SCADA data provided for July 2013 and the diurnal curve shown in **Figure 5.5-1**.

11.1.3 Background

A hydraulic model was developed as part of the City's 1999 Water Master Plan (WMP) in the Environmental Protection Agency's EPANET modeling software. This model was a skeletonized version of the City's actual distribution system, and focused on major water distribution and transmission mains.

As part of this master planning effort, the City initiated the development of a more robust hydraulic model, which is based in the City's GIS. The updated hydraulic model includes each of the GIS-developed water mains, as well as valve locations, hydrants, and hydrant laterals.

11.1.4 Level of Detail

The level of detail included in a hydraulic model is largely dependent on the amount and quality of infrastructure data available. This hydraulic model was developed from the GIS, and includes distribution mains, transmission mains, hydrants, hydrant laterals, and valves.

11.2 Modeling Software

There are several different hydraulic analysis software that are maintained by different software vendors. These software range from basic analysis and free cost to complex hydraulic analysis and very expensive to purchase and maintain. The City evaluated three software packages that would provide the most benefit to the City and ultimately chose Innovyze as the software vendor for consistency with their existing sewer model. However, the City chose to upgrade the water model to Innovyze's InfoWater to maintain consistency and integration with the existing GIS.

11.3 Performance Criteria

As part of the master planning effort, system performance criteria was developed and submitted to the City for approval. These criteria provide the basis for evaluation of the existing infrastructure, and guidelines for sizing future infrastructure to accommodate growth.

11.3.1 System Pressure

Service pressure is a basic level of service requirement to maintain good system operations and a reliable water supply to customers. Service pressures will vary depending on elevation and proximity to sources of supply. Thus, the City has established system pressure criteria to mitigate unnecessary reductions in levels of service. These criteria are established to avoid undesirable flow reductions that can occur when service pressures are too low, or the damage and unnecessarily high flow rates that can occur when service pressures are routinely too high.

The performance criteria used to evaluate the waters system are summarized as follows:

- Maximum Pressure: 80 pounds per square inch (psi)
- Minimum Pressure:
  - Maximum Day Demand, Existing Development: 35 psi
  - Maximum Day Demand, Future Development: 40 psi
  - Peak Hour Demand: 35 psi

11.3.2 Pipeline Criteria

The pipelines of the City's domestic water distribution system are separated into two categories depending on diameter:

- Regional Transmission Mains: 18-inches in diameter or larger
- Distribution Grid Mains: 12-inches to 18-inches in diameter

Both transmission and distribution mains are usually designed to convey the maximum expected flow condition. In municipal water systems, this condition is usually the greater of either the Peak Hour Demand or the Maximum Day Demand plus Fire Flow demand. Pipelines for the City are sized according to the peak velocity and headlosses.

Pipeline Velocity

High flow velocities can cause damage to pipes and lead to high head loss. Therefore it is desirable to keep the velocity below a predetermined limit. The criteria for maximum pipeline velocity are as follows:

- Regional Transmission Mains: Regional transmission mains were sized according to the following velocity criteria:
  - Average Day Demand: 3 ft/s
  - Peak Hour Demand: 5 ft/s
  - Maximum Day Demand: 5 ft/s
- Distribution Grid Mains: Distribution grid mains were sized according to the following velocity criteria:
  - Average Day Demand: 5 ft/s
  - Peak Hour Demand: 7 ft/s
  - Maximum Day Demand: 10 ft/s

Pipeline Headloss

Headloss is a loss of energy within pipes that results in reduced pressure within the water system. In an effort to mitigate the potential loss of pressure, water systems typically are sized to reduce the potential for increased headloss. The criteria for maximum headlosses in the pipes are as follows:

- Regional Transmission Mains: 3 ft/1,000 ft
- Distribution Grid Mains: 10 ft/1,000 ft

11.3.3 Fire Flow Requirements

Fire flows typically govern the sizing of the distribution system due to the intense demand in a short period of time. The City has adopted a uniform fire flow requirement for all land uses. The City's adopted fire flow for planning purposes is 1,800 gallons per minute with a residual pressure of 35 psi.

11.4 Model Construction

This section discusses the development of the hydraulic model including: developing infrastructure element databases, water demand allocation, and modeling scenario creation.

11.4.1 Nodes and Pipes

Nodes and pipes represent the physical aspects of the system within the model. A node is a computer representation of a place where demand may be allocated into the hydraulic system, while a pipe represents the distribution and transmission aspect of the water demand. The ground elevations of the nodes within the model were extracted from 10-foot contours obtained from the United States Geological Survey digital elevation model. The diameters of the pipelines within the model were based on the City's GIS records and a pipe roughness value of 130 was assumed for all existing pipes.

11.4.2 Wells

Groundwater wells within the model are typically characterized by the depth to groundwater as well as the design head and flow of the well pump. The depth to groundwater was extracted from historical pumping water levels, and where historical pumping water levels were not available, the depth to groundwater was estimated based on pumping water levels of wells in close proximity. The design head and flow for the groundwater well pumps were extracted from manufacturer pump curves.

Additionally, the well pressure-based controls were added into the hydraulic model for consistency with the current field operations. These controls start and stop the pump based on the downstream pressure.

11.4.3 Storage Tanks and Booster Pumps

The dimensions and elevations of storage tanks incorporated in the hydraulic model were based on as-built information provided by City staff. The as-built drawings, where available, were used as the basis for updating the hydraulic model. Additional information was provided by City staff for the pump stations, including: pump curves, design head and flow, and SCADA controls.

11.4.4 Surface Water Treatment Plant

The Southeast Surface Water Treatment Plant (SESWTP) clearwell tank and pump station are incorporated in the hydraulic model based on information received from City staff, including: as-built information, SCADA flow and pressure, and operational strategy. It should be noted that the treatment plant is currently operated based on Plant Operator discretion. At this time there are no pressure controls on the SESWTP. For evaluation purposes, it was assumed that the SESWTP delivery would be maximized to the fullest extent practicable, with the difference in demand being made up with well capacity.

11.4.5 Demands

The water demands and diurnal pattern were developed as discussed in Chapter 5 and included in the hydraulic model. Maximum Day Demands were based on July 2013 water meter records provided by the City.

11.4.6 Scenarios

Scenarios were established to conduct hydraulic analysis under different demand or operational conditions. The hydraulic model included the following scenarios: calibration, existing system analysis, and future system analysis. These scenarios are used to benchmark the hydraulic model, and evaluate demand conditions for existing and long term improvements.

11.5 Existing Conditions

The following sections document the results of the existing system evaluation.

11.5.1 Existing EPANET Model

The City's 1999 WMP included the use of a hydraulic model created in EPANET. This hydraulic model was calibrated and used for planning future improvements to the backbone water system. For this WMP Update, the existing EPANET model was used to spot check critical infrastructure.

11.5.2 Conversion to New Modeling Software

The conversion to Innovyze's InfoWater required incorporating the City's existing water system GIS records. This included adding distribution system pipelines and diameters, as well as verifying the location of water supply infrastructure. The existing system, which was included in the hydraulic model, is included on Figure 1.

Figure 11.5-1: Existing Water System

11.5.3 Calibration

Calibration can be performed for steady state conditions or for extended period simulations (EPS). For the purpose of this master plan an EPS calibration was performed, where model predictions were compared to diurnal operational changes in the water system. Operational settings for reservoirs, booster stations, wells, and PSVs were used to establish the operational parameters of the hydraulic model.

The calibration process was iterative and resulted with satisfactory comparison between the field measurements and the hydraulic model predictions at the well sites and storage reservoirs through the systems.

11.5.4 Result

The calibrated hydraulic model was used to evaluate the capacity of the existing water distribution system and recommend improvements to mitigate existing deficiencies. Using the calibrated model, areas with pressures below criteria for MDD and PHD conditions were identified. Additionally, a fire flow analysis was performed to determine areas throughout the City incapable of meeting the City's fire flow criteria of 1,800 gallons per minute. The hydraulic analysis results are discussed as follows:

- Maximum Day Demand – Maximum Pressures: **Figure 11.5-2** documents the maximum day demand conditions, showing the highest pressures experienced during that day. Generally, the system pressures range from 83 psi in the southwest portion of Pressure Zone 1, to near 50 psi in the northeast portion of Pressure Zone 2.
- Maximum Day Demand – Minimum Pressures: **Figure 11.5-3** documents the maximum day demand conditions, showing the lowest pressures experienced during that day. Generally, the system pressures range from 70 psi in the southwest portion of Pressure Zone 1, to near 40 psi in the northeast portion of Pressure Zones 1 and 2.
- Fire Flow Analysis: **Figure 11.5-4** documents the fire flow analysis for the City of Clovis water system. This figure documents the location of the deficient hydrants, whether the hydrant is located in a cul-de-sac or not, and provides the available fire flow.

11.5.5 Tarpey Village

Based on information received from City staff, the water distribution system serving users in Tarpey Village has one known active connection on Ashlan Avenue east of Sunnyside Avenue. It should be noted that the distribution system located in Tarpey Village is generally incapable of meeting the City's fire flow criteria. In order to improve hydraulic reliability for the Tarpey Village water distribution system, an additional connection to the City's water system was recommended as part of the future system improvements.

Figure 11.5-2: Maximum Pressures During Existing MDD

Figure 11.5-3: Minimum Pressures During Existing MDD

Figure 11.5-4: Hydrant Fire Flow Deficiencies

11.6 Future Conditions

This section documents the future conditions evaluation, including: demands, wells, storage, booster stations, and pressure sustaining valves.

11.6.1 Demands

Future demands, as discussed in Chapter 5, were included in the hydraulic model to size future infrastructure.

11.6.2 Future System Improvements

Future system improvements can generally be categorized in the following two ways: 1) Improvements to mitigate existing system deficiencies; and 2) Improvements required to serve future growth. The recommended improvements are documented in **Table 12.4-2** and shown on **Figure 12.4-1**are described in more detail in the following subsections. Future system improvements were given unique identification numbers to provide ease of reference for planning purposes. The Capital Improvement Program is discussed in greater detail, including phasing and associated costs, in Chapter 12.

Pipelines

Pipeline improvements recommended within the City's existing service area are primarily intended to mitigate existing system deficiencies and increase hydraulic reliability. Pipelines exceeding City criteria under future conditions were recommended for replacement. Additionally, pipelines were recommended to increase looping in areas throughout the City's service area for the purpose of increasing hydraulic reliability.

The alignments of the future system pipelines are generally intended to coincide with the current circulation element of the City's General Plan as well as alignments recommended by City staff. These pipelines were sized to meet future water demands.

Supply Capacity

In order to meet the growing demands of the General Plan buildout area, a combination of supply sources was recommended: surface water and groundwater. The supply sources are discussed in the following:

- Well W-T9: This future groundwater well is intended to connect to the existing Tarpey distribution system and is planned to have a capacity of 1,500 gpm, based on information received from City staff.
- Well W-11: This future groundwater well is intended to replace the existing groundwater well W-11, which has been inactive since 2014. This well is planned to have a capacity of 1,120 gpm based on information received from City staff.
- Well W-35: The location of this future groundwater well is based on direction from City staff.
- Wells W-44, W-45, W-46, W-47: City staff indicated that future groundwater wells outside of the City's existing service area must be constructed along or north of Shepherd Avenue due to water quality issues in other regions. Four additional wells were recommended along Shepherd Avenue between Willow Avenue and Sunnyside Avenue, each with a capacity of 500 gpm.

Surface Water Treatment Plant

Due to the increase in water demands, and the lack of adequate well sites, this master plan included the expansion of the existing water treatment plant and construction of a new surface water treatment facility. Each facility improvement is discussed as follows:

- Existing Southeast Surface Water Treatment Plant (SESWTP). The existing SESWTP has a capacity of 22.5 MGD. To meet future demand conditions, the SESWTP is planned to expand to a capacity of 45 MGD. The firm pumping capacity from the SESWTP is recommended at 42,000 gallons per minute (gpm).
- Planned Northeast Surface Water Treatment Plant (NESWTP). The northeastern portion of the General Planned area is planned for significant future growth. Due to topography and the lack of reliable groundwater supply, a future NESWTP is planned to meet the growing demand needs. The future NESWTP is planned at 20 MGD. The firm pumping capacity from the SESWTP is recommended at 22,000 gpm.

It should be noted that the surface water treatment plants are planned to have a raw water pipeline linking the facilities (see **Figure 12.4-1**). Future pump station and tank improvements are planned on this assumption. Should the raw water pipeline not be constructed, it is recommended that the future storage and pumping recommendations be revisited.

Storage Tanks

Ground level storage tanks are recommended to provide additional peak hour supply reliability to the Clovis water system. This additional storage must be able to provide the portion of peak hour demand not met by the surface and groundwater supplies and existing storage tanks. Based on future peak hour demand, the additional required storage is approximately 24 million gallons (MG). The storage tanks recommended to fulfill this additional required storage are summarized as follows:

- Tank T-6: A new 3.5 MG storage tank is recommended at the existing SESWTP.
- Tank T-7, T-8: These future storage tanks are intended to service development northeast of Highway 168 and have a combined capacity of 10 MG.
- Tanks T-9, T-10: These future storage tanks are intended to service areas in the northwest portions of Pressure Zones 1 and 2 and have a combined capacity of 10.5 MG.

Valve Recommendations

Two additional pressure sustaining valves (PSVs) are recommended from Pressure Zone 2 to Pressure Zone 1 to provide hydraulic reliability. Additionally, a PSV is recommended from Pressure Zone 3 to Pressure Zone 2. This PSV is intended to maximize deliveries from the proposed NESTWP.

Finally, a pressure reducing valve (PRV) is recommended from Pressure Zone 3 to Pressure Zone 2 at the approximate intersection of Thompson Avenue and Nees Avenue. This PRV is intended to provide peak hour and fire flow reliability to the area of Pressure Zone 2 generally south of Nees Avenue and east of Thompson Avenue.

12 Capital Improvements Program

12.1 Introduction

As the City of Clovis (Clovis) embarks on urbanization in growth areas beyond the current city limit it will trigger a need to expand water supplies, including groundwater, surface water, recharge and water banking. Increasing water demands will require the City to construct additional infrastructure to deliver water supplies to the growth areas. The purpose of this chapter is to develop a capital improvements program (CIP) which the City can use a road map for the expansion of its water distribution system. Major distribution infrastructure required to deliver this water will typically consist of 12- to 48-inch diameter pipes and transmission mains with wells, tanks, and booster pump stations at strategic locations.

This section provides an overview of the primary components associated with the proposed CIP. Major components include 1) cost assumptions, 2) cost components, 3) buildout conditions, and 4) phasing.

12.2 Assumptions and Limitations

Several assumptions were made in development of this section of the Water Master Plan, and should any of these assumption be modified recommendations contained herein may need to be updated as well. Given that most of the proposed facilities will be installed by and are triggered by new development, Clovis should revisit this plan and update this plan when conditions vary from those stated herein. Below is a list of assumption instrumental in development of this section.

- Facilities sizing are influenced by land uses from the 2014 General Plan (GP).
- Unit costs are consistent with a Class 3/4 designation as defined by the American Association of Cost Engineers, and are appropriate for feasibility studies and master plan level work.
- Capital projects only include infrastructure associated with the "backbone" of the water distribution system and as such other local improvements may be necessary for connecting to this system.
- Land acquisition cost was excluded from unit cost values and as such should be incorporated into project level budgets as needed, unless noted otherwise. In 2015, land cost in the Clovis area is about $200,000 per acre.
- Sub-mains and local piping necessary for connecting to the "backbone" of the water system are the responsibility of developers of projects that will utilize this resource.
- Lengths are based on data obtained from GIS.
- Costs include construction contingency of thirty percent (30%) and eighteen percent (18%) for engineering, survey, and project administration.

12.3 Program Component Costs

To help facilitate increased utilization of recycled water, Clovis adopted a policy requiring use of recycled water on public green spaces in new growth areas. Information presented in this analysis will lay out the framework for development conditions for potential water infrastructure within this area. Assumptions associated with this analysis are as follows:

- Land use information is based on the GP.
- Only pipelines associated with the "backbone" water distribution system will be sized.
- Development impacts are estimated based on plat maps provided by the City.
- Development of the City's GP update boundary will occur generally in the southeast and in the northwest areas within the sphere of influence (SOI) boundary.
- Development to the GP buildout boundary will generally occur in a northeasterly direction along the Highway 168 corridor.

12.3.1 Capital Costs

A budget level estimate of the various costs associated with the conveyance of potable water supplies is presented in detail below. Although the potable water costs presented below include the capital construction costs, there will also be annual costs associated with the operation and maintenance of those facilities, including approximately $2 million per year for purchase of surface water supplies.

Order-of-magnitude unit cost estimates were developed for pipelines, storage reservoirs, wells, and booster pump stations for 2016 conditions. Infrastructure cost estimates also include contingencies of thirty percent (30%) construction contingency and eighteen percent (18%) engineering, survey, and administration factors applied to unit costs. **Table 12.3-1** presents a summary of probable construction costs for major water infrastructure.

The cost estimates presented in this study are developed from cost curves, vendors, information obtained from previous studies, and recent project experience. The costs should be considered order-of-magnitude and have an expected accuracy range of +30 percent to -20 percent as defined by the American Association of Cost Engineers (AACE).

The cost estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. As constructed, final costs of the project will depend on actual labor and material costs, competitive market conditions, specific details of recommended modifications, final project scope, implementation schedule, and other variable factors. As a result, the final capital and operating project costs will vary from the estimates presented. Therefore, project feasibility and funding needs must be reviewed carefully prior to specific financial decisions to help ensure proper project evaluation and adequate funding.

Table 12.3-1: Probable Unit Cost of Proposed Infrastructure

Description	Unit Price ($/unit)	Description	Unit Price ($/each)
Pipeline[1]		***Distribution/Storage Facilities***[3,4]	
12-in Diameter	130/lf	2,500 gpm Booster Station	367,150
14-in Diameter	142/lf	42,000 gpm Booster Station	6,168,200
16-in Diameter	148/lf	3 MG Storage Tank	4,440,000
18-in Diameter	154/lf	7 MG Storage Tank	10,360,000
24-in Diameter	192/lf	6-in Pressure Sustaining Valve	135,000
30-in Diameter	306/lf	14-in Pressure Sustaining Valve	280,000
36-in Diameter	414/lf	10-in Pressure Reducing Valve	225,000
42-in Diameter	451/lf		
48-in Diameter	488/lf	***Other Facilities/Costs***	
Supply Facilities[2]		40-ac Recharge Basin[6]	1,180,000
500 gpm Well	2,072,000	Surface Water Purchase	2,000,000/yr
>500 gpm Well	2,960,000		
20-MGD SWTP[5]	27,800,000		
22.5-MGD SWTP Expansion[6]	29,970,000		

Notes:
1. Pipeline projects are denoted as P-XX in Table 12.4-2 through Table 12.5-5..
2. Well, Recharge Basin and SWTP Projects are denoted as W-XX, RC-XX, and SWTP-X, respectively, in Table 12.4-2 through Table 12.5-5.
3. Pump Station, Storage Tank and Pressure Sustaining Valve Projects are denoted as PS-XX, T-X, and PSV-X, respectively, in Table 12.4-2 through Table 12.5-5.
4. Unit prices for intermediary sizes are estimated linearly.
5. Price includes land acquisition
6. Land acquisition not included

12.3.2 Cost Components

Wells

Cost components for constructing new groundwater wells include test well construction, well development, furnishing and installation of controls and site work. Property acquisition costs were excluded because of the high level of variability of cost of property acquisition; some well sites do not necessitate property acquisition for a variety of reasons. Since most future water supply focus is on surface water supplies, well construction is not anticipated with high frequency.

Pipelines

Construction cost for pipelines includes furnishing and installation of key components and activities necessary for a fully operational facility. Major components and activities include Class 235 (C-905) pressure pipe, valves, minor utility interference, and minor street resurfacing when connecting to the existing system.

Easement costs were excluded because it was assumed construction activity occurs within existing rights-of-way for Clovis. Since most of the water system is in future growth areas, street resurfacing was also assumed minimal because existing roadways in rural areas would be improved as part of the development work. Pipeline unit costs range from a low of one hundred thirty dollars ($130) per linear foot (LF) for a twelve (12) inch diameter pipeline up to four-hundred eighty-eight dollars ($488) per LF for a forty-eight (48) inch diameter pipeline.

Surface Water Treatment Facilities

The existing Surface Water Treatment Plant (SWTP), with a capacity of 22.5 MGD, is expandable to 45MGD. An expansion of the SWTP would entail construction of new tanks, drying beds, diversion structures, and filtration system. Land acquisition is not anticipated or accounted for in the capital costs, as the property surrounding the SWTP should be sufficient for the expansion. An additional 20-MGD SWTP in the Northeast Village near the confluence of the Friant-Kern Canal and the Big Dry Creek would include acquisition approximately 4-acres of land.

Raw Water Facilities

The existing Surface Water Treatment Plant (SESWTP) is supplied with surface water through a diversion structure on the Enterprise Canal, which is offline for maintenance on a regular schedule. As the City relies more heavily on surface water, it is imperative their surface water supply be consistently available. A 42-inch raw water pipeline between the two SWTPs is included to provide redundant access to the surface water supply. Additionally, not included in the costs of the CIP discussed below, is the annual cost for purchasing surface water; $2 million should be anticipated annually for this cost.

Booster Pump Station

Utilizing cost data from past projects along with estimates from recent bids, a preliminary opinion of probable cost was developed for a booster pump station. Unit cost for this type of facility was based on a value of $147 per gallons per minute (gpm). The master planned infrastructure maps show five (5) booster pump stations, one at each water storage tank.

Water Storage Tank

The costs for constructing water storage facilities was generated from past, similar projects. The total cost for this type of project is based on a 2,000,000 gallon tank at $1.45 per gallon, including the site improvements and property acquisition. The lump sum cost including contingency and design is approximately $4,292,000. Five reservoirs are planned in this CIP.

Intentional Recharge and Groundwater Banking Facilities

The construction of intentional recharge or groundwater banking facilities is substantially similar in the construction process. Collectively, basin construction includes grading, excavation, diversion structures or pipelines, subsurface preparation and land acquisition. The CIP includes one, 40-acre recharge basin in the Northwest Village and one, 40-acre recharge basin at California State University, Fresno to augment the City's existing intentional recharge program, as shown in **Table 12.4-2**.

12.4 Buildout

There are five main areas that are considered for the proposed potable water distribution system expansion including Northwest Village, Clovis, Northeast Triangle, Loma Vista, and Northeast Village.

The backbone infrastructure necessary for conveying potable water to these areas is shown in **Figure 12.4-1.** Pipelines represent the prominent facility type within the buildout configuration of the potential potable water infrastructure system; total length of pipe is approximately seventy-seven (77) miles. The total cost of the proposed water system improvements is approximately $220 million with capital cost in the five (5) service areas varying from a low of about $2.5 million for the Northeast Triangle to a high of $80.3 million for the Northeast Village area. **Table 12.4-1** shows the anticipated distribution of capital costs and cumulative length of pipe within each area associated with these facilities as well as the total capital cost for the potential infrastructure.

Table 12.4-1: Capital Improvement Plan Costs for Urban Areas Water Infrastructure

Area	Total Pipe Length	Capital Cost
Clovis	64,280 LF	$71.9M
Northwest Village	84,025 LF	$55.9M
Northeast Triangle	16,725 LF	$2.5M
Loma Vista	61,450 LF	$9.6M
Northeast Village	180,225 LF	$80.2M
Totals	**406,705**	**$220.1M**

Notes:
Capital costs include the following infrastructure components: pipelines, wells, booster pump stations, tanks, a new surface water treatment plant and expansion of the existing surface water treatment plant.
No infrastructure is planned for the following areas: Northeast Corner, Between Canals, Southeast Corner, or Northern Rural.

Figure 12.4-1: Water Infrastructure at Buildout

Table 12.4-2: Capital Improvement Plan Costs for Backbone Water Infrastructure

Item No.	Description	Limits	Type	Length (ft)	Cost
Clovis					
Pipeline Improvements					
P-1	16" Water Main in Shepherd Ave	From Clovis Ave to 500' w/o Sunnyside Ave	New	2,175	$321,900
P-2	16" Water Main in Shepherd Ave	From Preuss Ave to Fowler Ave	New	4,525	$669,700
P-3	16" Water Main in Sunnyside Ave	From Teague Ave to Shepherd Ave	New	2,625	$388,500
P-4	12" Water Main in Sunnyside Ave	From Nees Ave to Teague Ave	New	2,650	$344,500
P-5	12" Water Main in Teague Ave	From Clovis Ave to Sunnyside Ave	New	2,675	$347,800
P-6	16" Water Main in Teague Ave	From Sunnyside Ave to Armstrong Ave	New	5,375	$795,500
P-7	12" Water Main in Nees Ave	From Sunnyside Ave to Stanford Ave	New	1,475	$191,800
P-10	12" Water Main in Alluvial Ave	From 700' e/o Fowler Ave to Armstrong Ave	New	1,950	$253,500
P-11	16" Water Main in Tollhouse Rd	From Burgan Ave to 560' ne/o Burgan Ave	Replace	625	$92,500
P-12	12" Water Main in Burgan Ave	From Tollhouse Rd to 150' s/o Tollhouse Rd	Replace	150	$19,500
P-13	12" Water Main in Clovis Ave	From Donner Ave to 200' s/o Gettysburg Ave	New	650	$84,500
P-45	12" Water Main in Locan Ave	From Alluvial Ave to Tollhouse Rd	New	500	$65,000
P-46	12" Water Main in Alluvial Ave	From Locan Ave to De Wolf Ave	New	2,600	$338,000
P-47	12" Water Main in De Wolf Ave	From Herndon Ave to Alluvial Ave	New	2,650	$344,500
P-48	12" Water Main in Herndon Ave	From Locan Ave to De Wolf Ave	New	1,975	$256,800
	42" Raw Water Main	From SESWTP to NESWTP	New	31,680	$14,287,700
Well Improvements					
W-11	1120 gpm Well at Fowler and Keats Aves		Replace		$2,960,000
W-35	500 gpm Well at Clovis and Santa Ana Aves		New		$2,072,000
W-T9	1500 gpm Well at Minnewawa and Gettysburg Aves		New		$2,960,000
Tank Improvements					
T-6	3.5 MG Tank at SWTP[1]		New		$7,511,000
Pump Station Improvements					
PS-SESWTP	42000 gpm Pump Station at Southeast SWTP		New		$6,168,185

Item No.	Description	Limits	Type	Length (ft)	Cost
Other System Improvements					
SWTP-1	22.5-MGD SWTP Expansion[3]		New		$29,970,000
PSV6	8" PSV at Herndon Ave 500' e/o Coventry Ave		New		$180,000
PSV7	6" PSV at Clovis Ave and Alluvial Ave		New		$135,000
Recharge Basin Improvements					
RC-1	40-ac CSUF Recharge Basin		New		$1,180,000
			Clovis Subtotal	**64,280**	**$71,937,885**
Northwest Village					
Pipeline Improvements					
P-14	12" Water Main in Copper Ave	From Willow Ave to Sunnyside Ave	New	10,175	$1,322,800
P-15	12" Water Main in International Ave	From Willow Ave to Sunnyside Ave	New	10,250	$1,332,500
P-16	12" Water Main in Behymer Ave	From Willow Ave to Peach Ave	New	2,850	$370,500
P-17	16" Water Main in Behymer Ave	From Peach Ave to Future Arterial	New	3,950	$584,600
P-18	24" Water Main in Behymer Ave	From Future Arterial to Future Collector	New	1,875	$360,000
P-19	12" Water Main in Behymer Ave	From Future Arterial to Sunnyside Ave	New	1,400	$182,000
P-20	12" Water Main in Willow Ave	From Behymer Ave to Copper Ave	New	5,250	$682,600
P-21	12" Water Main in Peach Ave	From Behymer Ave to Copper Ave	New	5,325	$692,300
P-22	16" Water Main in Future Arterial	From International Ave to Copper Ave	New	2,650	$392,200
P-23	24" Water Main in Future Arterial	From Behymer Ave to International Ave	New	2,650	$508,800
P-24	12" Water Main in Future Arterial	From Perrin Ave to Behymer Ave	New	2,600	$338,000
P-25	16" Water Main in Willow Ave	From Shepherd Ave to Perrin Ave	New	2,600	$384,800
P-26	12" Water Main in Willow Ave	From Perrin Ave to Behymer Ave	New	2,625	$341,300
P-27	12" Water Main in Perrin Ave	From Willow Ave to 1,400' e/o Willow Ave	New	1,375	$178,800
P-28	12" Water Main in Miramar Ln	From Christopher Dr to Plymouth Ave	New	2,575	$334,800
P-29	12" Water Main in Peach Ave	From Plymouth Ave to Behymer Ave	New	1,275	$165,800
P-30	12" Water Main in Plymouth Ave	From Miramar Ln to Villa Ave	New	2,725	$354,300
P-31	16" Water Main in Peach Ave	From Shepherd Ave to Christopher Dr	New	1,325	$196,100
P-32	12" Water Main in Christopher Dr	From Miramar Ln to Villa Ave	New	2,775	$360,800

Item No.	Description	Limits	Type	Length (ft)	Cost
P-33	12" Water Main in Perrin Ave	From Villa Ave to Minnewawa Ave	New	1,150	$149,500
P-34	12" Water Main in Villa Ave	From Christopher Dr to Plymouth Ave	New	2,550	$331,600
P-35	16" Water Main in Minnewawa Ave	From Shepherd Ave to Perrin Ave	New	2,675	$395,900
P-36	12" Water Main in Future Arterial	From Shepherd Ave to Perrin Ave	New	3,200	$416,000
P-37	16" Water Main in Future Collector	From Lexington Ave to Perrin Ave	New	1,525	$225,700
P-38	24" Water Main in Future Collector	From Perrin Ave to Behymer Ave	New	2,625	$504,000
P-39	24" Water Main in Future Collector	From Dupree Ln to Elm Ave	New	1,025	$196,800
P-40	24" Water Main in Sunnyside Ave	From Shepherd Ave to Perrin Ave	New	3,025	$580,800
Well Improvements					
W-44	500 gpm Well at Willow Ave and Yeargin Ave		New		$2,072,000
W-45	500 gpm Well at Minnewawa Ave and Christopher Dr		New		$2,072,000
W-46	500 gpm Well at Clovis Ave and Shepherd Ave		New		$2,072,000
W-47	500 gpm Well at Sunnyside Ave and Christopher Dr		New		$2,072,000
Tank Improvements					
T-9	7 MG Tank at Perrin Ave and Future Collector		New		$15,022,000
T-10	3.5 MG Tank at Christopher Dr and Peach Ave		New		$7,511,000
Pump Station Improvements					
PS-T9	4900 gpm Pump Station at Perrin Ave and Future Collector		New		$719,622
PS-T10	2500 gpm Pump Station at Christopher Dr and Peach Ave		New		$367,154
Recharge Basin Improvements					
RC-2	40-ac Recharge Basin		New		$12,060,000
		Northwest Village Subtotal		**84,025**	**$55,850,975**
Northeast Triangle					
Pipeline Improvements					
P-8	12" Water Main in Locan Ave	From Enterprise Ave to Loyola Ave	New	2,725	$354,300
P-9	12" Water Main in Owens Mountain Pkwy	From 600' e/o Alluvial Ave to Locan Ave	New	2,400	$312,000

Item No.	Description	Limits	Type	Length (ft)	Cost
P-41	12" Water Main in Future Local	From intersection of Shepherd Ave and Armstrong Ave to intersection of Shepherd Ave and Locan Ave	New	7,775	$1,010,800
P-42	12" Water Main in Future Local	From Future Local to 400' n/o Perrin Ave	New	1,650	$214,500
P-43	12" Water Main in Future Local	From Future Local to 400' n/o Perrin Ave	New	925	$120,300
P-44	12" Water Main in Nees Ave	From Locan Ave to Redington Ave	New	1,250	$162,500
Other System Improvements					
PSV8	14" PSV at CA-168 and Shepherd Ave		New		$315,000
		Northeast Triangle Subtotal		**16,725**	**$2,489,400**
Loma Vista					
Pipeline Improvements					
P-98	36" Water Main at SWTP	From SWTP to 400' w/o Leonard Ave	Parallel	425	$176,000
P-99	30" Water Main at SWTP	From SWTP to Bullard Ave	Parallel	1,525	$466,700
P-100	30" Water Main in Bullard Ave	From Locan Ave to Cordova Ave	Parallel	4,350	$1,331,100
P-101	36" Water Main in Leonard Ave	From Barstow Ave to Wrenwood Ave	Replace	1,425	$590,000
P-102	12" Water Main in Leonard Ave	From Wrenwood Ave to Bullard Ave	New	1,275	$165,800
P-103	12" Water Main in Bullard Ave	From Leonard Ave to Emily Ave	New	1,625	$211,300
P-104	12" Water Main in Future ROW	From Barstow Ave to Bullard Ave	New	3,800	$494,000
P-105	12" Water Main in Barstow Ave	From Leonard Ave to 1,000' e/o Leonard Ave	New	1,050	$136,500
P-106	12" Water Main in Future ROW	From Barstow Ave to San Jose Ave	New	1,575	$204,800
P-107	12" Water Main in San Jose Ave	From Future ROW to Highland Ave	New	1,325	$172,300
P-108	12" Water Main in Highland Ave	From San Jose Ave to Dakota Ave	New	9,175	$1,192,800
P-109	12" Water Main in Future Collector	From Shaw Ave to Gettysburg Ave	New	2,425	$315,300
P-110	12" Water Main in Thompson Ave	From Gettysburg Ave to 600' s/o Ashlan Ave	New	4,525	$588,300
P-111	12" Water Main in McCall Ave	From Shaw Ave to 600' s/o Ashlan Ave	New	6,575	$854,800
P-112	12" Water Main in Shaw Ave	From De Wolf Ave to Leonard Ave	New	2,600	$338,000
P-113	18" Water Main in Shaw Ave	From Langley Ave to Highland Ave	New	1,500	$231,000
P-114	12" Water Main in Shaw Ave	From Highland Ave to McCall Ave	New	5,175	$672,800
P-115	12" Water Main in Gettysburg Ave	From Leonard Ave to Thompson Ave	New	5,225	$679,300

Item No.	Description	Limits	Type	Length (ft)	Cost
P-116	12" Water Main in Future Collector	From Thompson Ave to McCall Ave	New	2,625	$341,300
P-117	12" Water Main in Ashlan Ave	From 600' e/o McCall Ave to McCall Ave	New	575	$74,800
P-118	12" Water Main in Dakota Ave	From Leonard Ave to Highland Ave	New	2,675	$347,800
			Loma Vista Subtotal	**61,450**	**$9,584,700**
Northeast Village					
Pipeline Improvements					
P-49	16" Water Main in Tollhouse Rd	From Locan Ave to Shepherd Ave	New	12,600	$1,864,800
P-50	14" Water Main in Shepherd Ave	From Highland Ave to CA-168	New	2,375	$337,300
P-51	12" Water Main in Nees Ave	From CA-168 to Future Arterial	New	7,325	$952,300
P-52	12" Water Main in Future Arterial	From CA-168 to Alluvial Ave	New	8,625	$1,121,300
P-53	12" Water Main in McCall Ave	From Herndon Ave to Alluvial Ave	New	2,500	$325,000
P-54	12" Water Main in Thompson Ave	From Herndon Ave to Future Arterial	New	4,875	$633,800
P-55	12" Water Main in Alluvial Ave	From Thompson Ave to McCall Ave	New	2,400	$312,000
P-56	12" Water Main in Herndon Ave	From Thompson Ave to Constellation Ave	New	3,650	$474,500
P-57	16" Water Main in Future Collector	From Future Arterial to Future Collector	New	3,650	$540,200
P-58	16" Water Main in Future Collector	From Future Collector to Future Arterial	New	1,550	$229,400
P-59	24" Water Main in Future Arterial	From Future Arterial to CA-168	New	2,025	$388,800
P-60	16" Water Main in Future Arterial	From Future Collector to Future Collector	New	1,775	$262,700
P-61	12" Water Main in Future Arterial	From Future Arterial to Future Collector	New	2,525	$328,300
P-62	12" Water Main in Future Collector	From Future Arterial to Future Arterial	New	5,350	$695,500
P-63	12" Water Main in Future Arterial	From Future Collector to Alluvial Ave	New	4,650	$604,500
P-64	12" Water Main in Alluvial Ave	From McCall Ave to Future Collector	New	8,400	$1,092,000
P-65	12" Water Main in Future Collector	From Locust Ave to Future Collector	New	5,650	$734,500
P-66	12" Water Main in Future Collector	From Locust Ave to Alluvial Ave	New	1,500	$195,000
P-67	12" Water Main in Future Collector	From Locust Ave to Alluvial Ave	New	1,500	$195,000
P-68	12" Water Main in Future Collector	From Future Collector to Future Collector	New	5,425	$705,300
P-69	12" Water Main in Future Collector	From Future Collector to Future Arterial	New	2,025	$263,300
P-70	16" Water Main in Future Collector	From Future Collector to Future Arterial	New	2,000	$296,000

Item No.	Description	Limits	Type	Length (ft)	Cost
P-71	12" Water Main in Future Arterial	From Future Collector to Future Collector	New	5,300	$689,000
P-72	24" Water Main in Future Arterial	From Future Collector to CA-168	New	2,500	$480,000
P-73	24" Water Main in CA-168	From Shepherd Ave to Future Arterial	New	4,825	$926,400
P-74	36" Water Main in CA-168	From Future Arterial to Friant-Kern Canal	New	3,625	$1,500,800
P-75	30" Water Main in CA-168	From Friant-Kern Canal to Future Arterial	New	2,000	$612,000
P-76	24" Water Main in Future Arterial	From CA-168 to Future Collector	New	1,975	$379,200
P-77	16" Water Main in Future Arterial	From Future Collector to Future Collector	New	4,700	$695,600
P-78	12" Water Main in Future Arterial	From Future Collector to Future Arterial	New	4,000	$520,000
P-79	24" Water Main in Future ROW	From CA-168 to Future Collector	New	4,200	$806,400
P-80	24" Water Main in Future ROW	From Future Collector to Future Collector	New	5,075	$974,400
P-81	12" Water Main in Future Arterial	From CA-168 to 2,000' n/o CA-168	New	2,175	$282,800
P-82	16" Water Main in Future Collector	From Future Arterial to Friant-Kern Canal	New	3,150	$466,200
P-83	12" Water Main in Future Collector	From Future Arterial to Friant-Kern Canal	New	1,725	$224,300
P-84	12" Water Main in Future Arterial	From Future Arterial to 1,600' e/o Future Arterial	New	1,575	$204,800
P-85	16" Water Main in Future ROW	From Future Collector to Future Arterial	New	3,250	$481,000
P-86	12" Water Main in Future Collector	From Friant-Kern Canal to 1300’ e/o Friant-Kern Canal	New	1,300	$169,000
P-87	16" Water Main in Future Collector	From 1,300' e/o Friant-Kern Canal to Future Arterial	New	4,075	$603,100
P-88	16" Water Main in Future Collector	From Friant-Kern Canal to Future Arterial	New	1,875	$277,500
P-89	12" Water Main in Future Arterial	From 2,000' s/o Future Collector to Future Collector	New	2,125	$276,300
P-90	12" Water Main in Future Arterial	From Future Collector to Future Collector	New	4,100	$533,000
P-91	12" Water Main in Future Arterial	From Future Collector to Future ROW	New	4,175	$542,800
P-92	12" Water Main in Future Arterial	From Future ROW to 1,600 e/o Future Arterial	New	1,500	$195,000
P-93	12" Water Main in Future ROW	From Future Arterial to Future ROW	New	1,800	$234,000
P-94	12" Water Main in Future Collector	From Future Arterial to Future ROW	New	3,875	$503,800
P-95	12" Water Main in Future Collector	From Future Arterial to Future ROW	New	1,600	$208,000
P-96	12" Water Main in Future ROW	From Future Collector to Future ROW	New	6,625	$861,300
P-97	12" Water Main in Future ROW	From Future ROW to Future ROW	New	4,725	$614,300

Item No.	Description	Limits	Type	Length (ft)	Cost
Tank Improvements					
T-7	7 MG Tank at Northeast SWTP		New		$15,022,000
T-8	3 MG Tank at Future Collector e/o Friant-Kern Canal		New		$6,438,000
Pump Station Improvements					
PS-NESWTP	22000 gpm Pump Station at Northeast SWTP		New		$3,230,954
PS-T8	4900 gpm Pump Station at Future Collector e/o Friant-Kern Canal		New		$719,622
Other System Improvements					
SWTP-2	20-MGD Northeast SWTP		New		$27,800,000
PRV1	10" PRV at Future Arterial and Thompson Ave		New		$225,000
			Northeast Village Subtotal	**180,225**	**$80,248,075**
			Total	**406,705**	**$220,111,035**

12.5 Phasing

The capital improvements will be constructed in phases based on the location of existing facilities, new growth areas, demands, and availability of surface and recycled water from the SWTP and STWRF. For the purposes of this capital improvement program, improvements were divided into four (4) phases (see **Figure 12.5-1**) and are summarized below:

- Phase 1 – 2016-2020
- Phase 2 – 2020-2030
- Phase 3 – 2030-2040
- Phase 4 – 2040-2050

12.5.1 Delivery Infrastructure

The CIP for each phase was analyzed by village of implementation, sizing, alignment, quantity, and cost.

Significant aspects of the Phase 1 implementation include four wells in the Northwest Village, the FKC turnout and associated 42" raw water pipeline, two additional water storage tanks , a 2,500 gpm pump station, six wells and 12"-30" pipelines to serve the Northwest Village and the Harlan Ranch community. Initial cost estimates for Phase 1 are $54.1 million with 100,360 LF of pipeline installed. **Table 12.5-2** provides the detailed implementation plan and cost estimate for Phase 1.

Phase 2 includes the Northeast SWTP, additional recharge facilities, two storage tanks with a total capacity of 14 MG, backbone infrastructure for growth in the eastern portion of Loma Vista and the southern portion of the Northwest village. Additional facilities within the Northeast Village, Northeast Triangle and Clovis, will also be served as shown in **Figure 12.4-1**. Potential capital improvements for Phase 2 are presented in **Table 12.5-3**. The initial cost estimate provided is $93.9 million with 109,095 LF of pipeline laid.

Phase 3 would consist primarily of the SWTP expansion and new pump station, additional recharge facilities, completing infrastructure in Loma Vista, further expansion into the Northwest Village, and extension of pipes into the Northeast Triangle and Northeast Village. Potential capital improvements for Phase 3 provided in **Table 12.5-4**, with a preliminary cost estimate of $42.8 million and 40,860 LF of pipe installed.

Phase 4 would include buildout of water distribution facilities and major infrastructure improvements in the Northeast Village including one storage tanks and pump station. Potential capital improvements for Phase 4 (buildout) are provided in **Table 12.5-5**. Estimated capital cost for Phase 4 improvement was about $29.3 million with 156,390 LF of pipeline constructed.

Table 12.5-1: Capital Improvement Plan Costs for Urban Areas Water Infrastructure

Phase	Total Pipe Length	Capital Cost
Phase 1 (2016-2020)	100,360 LF	$54.1M
Phase 2 (2020-2030)	109,095 LF	$93.9M
Phase 3 (2030-2040)	40,860 LF	$42.8M
Phase 4 (2040-2080)	156,390 LF	$29.3M
Totals	**406,705**	**$220.1M**

Figure 12.5-1: Water Infrastructure Phasing

Table 12.5-2: Capital Improvements Phase 1 (2016-2020)

Item No.	Description	Limits	Type	Length (ft)	Cost
Phase 1 (2016-2020)					
Clovis					
P-1	16" Water Main in Shepherd Ave	From Clovis Ave to 500' w/o Sunnyside Ave	New	2,175	$321,900
P-2	16" Water Main in Shepherd Ave	From Preuss Ave to Fowler Ave	New	4,525	$669,700
P-3	16" Water Main in Sunnyside Ave	From Teague Ave to Shepherd Ave	New	2,625	$388,500
P-4	12" Water Main in Sunnyside Ave	From Nees Ave to Teague Ave	New	2,650	$344,500
P-5	12" Water Main in Teague Ave	From Clovis Ave to Sunnyside Ave	New	2,675	$347,800
P-6	16" Water Main in Teague Ave	From Sunnyside Ave to Armstrong Ave	New	5,375	$795,500
P-7	12" Water Main in Nees Ave	From Sunnyside Ave to Stanford Ave	New	1,475	$191,800
P-10	12" Water Main in Alluvial Ave	From 700' e/o Fowler Ave to Armstrong Ave	New	1,950	$253,500
P-11	16" Water Main in Tollhouse Rd	From Burgan Ave to 560' ne/o Burgan Ave	Replace 12"	625	$92,500
P-12	12" Water Main in Burgan Ave	From Tollhouse Rd to 150' s/o Tollhouse Rd	Replace 8"	150	$19,500
P-13	12" Water Main in Clovis Ave	From Donner Ave to 200' s/o Gettysburg Ave	New	650	$84,500
	42" Raw Water Main[1]	From SESWTP to NESWTP	New	31,680	$14,287,700
W-11	1120 gpm Well at Fowler Ave and Keats Ave[2]		Replace		$2,960,000
W-35	500 gpm Well at Clovis Ave and Santa Ana Ave[2]		New		$2,072,000
T-6	3.5 MG Tank at Southeast SWTP[2]		New		$7,511,000
PSV6	8" PSV at Herndon Ave 500' e/o Coventry Ave		New		$180,000
PSV7	6" PSV at Clovis Ave and Alluvial Ave		New		$135,000
Northwest Village					
P-25	16" Water Main in Willow Ave	From Shepherd Ave to Perrin Ave	New	2,600	$384,800
P-27	12" Water Main in Perrin Ave	From Willow Ave to 1,400' e/o Willow Ave	New	1,375	$178,800
P-28a	12" Water Main in Miramar Ln	From Christopher Dr to Perrin Ave	New	1,285	$167,100
P-31	16" Water Main in Peach Ave	From Shepherd Ave to Christopher Dr	New	1,325	$196,100
P-32	12" Water Main in Christopher Dr	From Miramar Ln to Villa Ave	New	2,775	$360,800
P-33	12" Water Main in Perrin Ave	From Villa Ave to Minnewawa Ave	New	1,150	$149,500
P-34a	12" Water Main in Villa Ave	From Christopher Dr to Perrin Ave	New	1,275	$165,800

Item No.	Description	Limits	Type	Length (ft)	Cost
P-35	16" Water Main in Minnewawa Ave	From Shepherd Ave to Perrin Ave	New	2,675	$395,900
P-36	12" Water Main in Future Arterial	From Shepherd Ave to Perrin Ave	New	3,200	$416,000
P-37	16" Water Main in Future Collector	From Lexington Ave to Perrin Ave	New	1,525	$225,700
P-39	24" Water Main in Future Collector	From Dupree Ln to Elm Ave	New	1,025	$196,800
P-40	24" Water Main in Sunnyside Ave	From Shepherd Ave to Perrin Ave	New	3,025	$580,800
W-44	500 gpm Well at Willow Ave and Yeargin Ave[2]		New		$2,072,000
W-45	500 gpm Well at Minnewawa Ave and Christopher Dr[2]		New		$2,072,000
W-46	500 gpm Well at Clovis Ave and Shepherd Ave[2]		New		$2,072,000
W-47	500 gpm Well at Sunnyside Ave and Christopher Dr[2]		New		$2,072,000
T-10	3.5 MG Tank at Christopher Dr and Peach Ave[3]		New		$7,511,000
PS-T10	2500 gpm Pump Station at Christopher Dr and Peach Ave[3]		New		$367,154
Northeast Triangle					
P-8	12" Water Main in Locan Ave	From Enterprise Ave to Loyola Ave	New	2,725	$354,300
P-9	12" Water Main in Owens Mountain Pkwy	From 600' e/o Alluvial Ave to Locan Ave	New	2,400	$312,000
P-44	12" Water Main in Nees Ave	From Locan Ave to Redington Ave	New	1,250	$162,500
Loma Vista					
P-98	36" Water Main at SWTP	From SWTP to 400' w/o Leonard Ave	Parallel	425	$176,000
P-99	30" Water Main at SWTP	From SWTP to Bullard Ave	Parallel	1,525	$466,700
P-100	30" Water Main in Bullard Ave	From Locan Ave to Cordova Ave	Parallel	4,350	$1,331,100
P-108a	12" Water Main in Highland Ave	From Ashlan Ave to Dakota Ave	New	2,620	$340,600
P-112	12" Water Main in Shaw Ave	From De Wolf Ave to Leonard Ave	New	2,600	$338,000
P-118	12" Water Main in Dakota Ave	From Leonard Ave to Highland Ave	New	2,675	$347,800
			Phase 1 (2016-2020) Subtotal	**100,360**	**$54,068,654**

Notes:
1. Raw water main and turnout allows uninterrupted use of the SWTP and is a precursor to the SESWTP Expansion and NESWTP Construction. Assumes a construction location near the Friant-Kern Canal and Big Dry Creek crossing. Main alignment would remain in existing rights-of-way as much as possible.
2. Well improvements are needed in stages to continue developing in the Village.
3. Improvements needed before developing Phase 2 in the Village.

Table 12.5-3: Capital Improvements Phase 2 (2020-2030)

Item No.	Description	Limits	Type	Length (ft)	Cost
Phase 2 (2020-2030)					
Clovis					
P-45	12" Water Main in Locan Ave	From Alluvial Ave to Tollhouse Rd	New	500	$65,000
P-46	12" Water Main in Alluvial Ave	From Locan Ave to De Wolf Ave	New	2,600	$338,000
P-47	12" Water Main in De Wolf Ave	From Herndon Ave to Alluvial Ave	New	2,650	$344,500
P-48	12" Water Main in Herndon Ave	From Locan Ave to De Wolf Ave	New	1,975	$256,800
W-T9	1500 gpm Well at Minnewawa Ave and Gettysburg Ave		New		$2,960,000
Northwest Village					
P-16	12" Water Main in Behymer Ave	From Willow Ave to Peach Ave	New	2,850	$370,500
P-17	16" Water Main in Behymer Ave	From Peach Ave to Future Arterial	New	3,950	$584,600
P-18	24" Water Main in Behymer Ave	From Future Arterial to Future Collector	New	1,875	$360,000
P-19	12" Water Main in Behymer Ave	From Future Arterial to Sunnyside Ave	New	1,400	$182,000
P-24	12" Water Main in Future Arterial	From Perrin Ave to Behymer Ave	New	2,600	$338,000
P-26	12" Water Main in Willow Ave	From Perrin Ave to Behymer Ave	New	2,625	$341,300
P-28b	12" Water Main in Miramar Ln	From Perrin Ave to Plymouth Ave	New	1,290	$167,700
P-29	12" Water Main in Peach Ave	From Plymouth Ave to Behymer Ave	New	1,275	$165,800
P-30	12" Water Main in Plymouth Ave	From Miramar Ln to Villa Ave	New	2,725	$354,300
P-34b	12" Water Main in Villa Ave	From Perrin Ave to Plymouth Ave	New	1,275	$165,800
P-38	24" Water Main in Future Collector	From Perrin Ave to Behymer Ave	New	2,625	$504,000
T-9	7 MG Tank at Perrin Ave and Future Collector[1]		New		$15,022,000
PS-T9	4900 gpm Pump Station at Perrin Ave and Future Collector[1]		New		$719,622
RC-2	40-ac Recharge Basin		New		$12,060,000
Northeast Triangle					
PSV8	14" PSV at CA-168 and Shepherd Ave		New		$315,000
Loma Vista					
P-101	36" Water Main in Leonard Ave	From Barstow Ave to Wrenwood Ave	Replace 30"	1,425	$590,000
P-102	12" Water Main in Leonard Ave	From Wrenwood Ave to Bullard Ave	New	1,275	$165,800

Item No.	Description	Limits	Type	Length (ft)	Cost
P-103	12" Water Main in Bullard Ave	From Leonard Ave to Emily Ave	New	1,625	$211,300
P-104	12" Water Main in Future ROW	From Barstow Ave to Bullard Ave	New	3,800	$494,000
P-105	12" Water Main in Barstow Ave	From Leonard Ave to 1,000' e/o Leonard Ave	New	1,050	$136,500
P-106	12" Water Main in Future ROW	From Barstow Ave to San Jose Ave	New	1,575	$204,800
P-107	12" Water Main in San Jose Ave	From Future ROW to Highland Ave	New	1,325	$172,300
P-108b	12" Water Main in Highland Ave	From San Jose Ave to Ashlan Ave	New	6,555	$852,200
P-109	12" Water Main in Future Collector	From Shaw Ave to Gettysburg Ave	New	2,425	$315,300
P-110	12" Water Main in Thompson Ave	From Gettysburg Ave to 600' s/o Ashlan Ave	New	4,525	$588,300
P-113	18" Water Main in Shaw Ave	From Langley Ave to Highland Ave	New	1,500	$231,000
P-115	12" Water Main in Gettysburg Ave	From Leonard Ave to Thompson Ave	New	5,225	$679,300
P-116	12" Water Main in Future Collector	From Thompson Ave to McCall Ave	New	2,625	$341,300
Northeast Village					
P-49	16" Water Main in Tollhouse Rd	From Locan Ave to Shepherd Ave	New	12,600	$1,864,800
P-50	14" Water Main in Shepherd Ave	From Highland Ave to CA-168	New	2,375	$337,300
P-51	12" Water Main in Nees Ave	From CA-168 to Future Arterial	New	7,325	$952,300
P-52a	12" Water Main in Future Arterial	From CA-168 to Future Collector	New	3,975	$516,800
P-57	16" Water Main in Future Collector	From Future Arterial to Future Collector	New	3,650	$540,200
P-58	16" Water Main in Future Collector	From Future Collector to Future Arterial	New	1,550	$229,400
P-59	24" Water Main in Future Arterial	From Future Arterial to CA-168	New	2,025	$388,800
P-73	24" Water Main in CA-168	From Shepherd Ave to Future Arterial	New	4,825	$926,400
P-74	36" Water Main in CA-168	From Future Arterial to Friant-Kern Canal	New	3,625	$1,500,800
T-7	7 MG Tank at Northeast SWTP[2]		New		$15,022,000
PS-NESWTP	22,000 gpm Pump Station at Northeast SWTP[2]		New		$3,230,954
SWTP-2	20-MGD Northeast SWTP [2]		New		$27,800,000
		Phase 2 (2020-2030) Subtotal		**109,095**	**$93,906,775**

Notes:
1. Improvements are needed prior to developing north of Perrin Avenue in the Village.
2. Improvements are needed prior to developing Northeast Village east of Shepherd Ave and Hwy 168 intersection. The timing of this improvement can be exchanged with the SESWTP Expansion planned in Phase 3.

Table 12.5-4: Capital Improvements Phase 3 (2030-2040)

Item No.	Description	Limits	Type	Length (ft)	Cost
Phase 3 (2030-2040)					
Clovis					
SWTP-1	22.5-MGD SWTP Expansion[1]		New		$29,970,000
PS-SESWTP	42000 gpm Pump Station at Southeast SWTP[1]		New		$6,168,185
RC-1	40-ac CSUF Recharge Basin		New		$1,180,000
Northwest Village					
P-15	12" Water Main in International Ave	From Willow Ave to Sunnyside Ave	New	10,250	$1,332,500
P-20a	12" Water Main in Willow Ave	From Behymer Ave to International Ave	New	2,625	$341,300
P-21a	12" Water Main in Peach Ave	From Behymer Ave to International Ave	New	2,660	$345,800
P-23	24" Water Main in Future Arterial	From Behymer Ave to International Ave	New	2,650	$508,800
Northeast Triangle					
P-41	12" Water Main in Future Local	From intersection of Shepherd and Armstrong Ave to intersection of Shepherd and Locan Ave	New	7,775	$1,010,800
P-42	12" Water Main in Future Local	From Future Local to 400' n/o Perrin Ave	New	1,650	$214,500
P-43	12" Water Main in Future Local	From Future Local to 400' n/o Perrin Ave	New	925	$120,300
Loma Vista					
P-111	12" Water Main in McCall Ave	From Shaw Ave to 600' s/o Ashlan Ave	New	6,575	$854,800
P-114	12" Water Main in Shaw Ave	From Highland Ave to McCall Ave	New	5,175	$672,800
P-117	12" Water Main in Ashlan Ave	From 600' e/o McCall Ave to McCall Ave	New	575	$74,800
			Phase 3 (2030-2040) Subtotal	**40,860**	**$42,794,585**

Notes:

1. The timing of these improvements can be exchanged with the SESWTP Expansion planned in Phase 3; however, both SESWTP Expansion and NESWTP construction must be completed prior to developing in the Northeast Village, east of the Pressure Zone 4 boundary if all planned wells are constructed at or above planned capacity.

Table 12.5-5: Capital Improvements Phase 4 (2040-2080)

Item No.	Description	Limits	Replace or New	Length (ft)	Cost
Phase 4 (2040-2080)					
Northwest Village					
P-14	12" Water Main in Copper Ave	From Willow Ave to Sunnyside Ave	New	10,175	$1,322,800
P-20b	12" Water Main in Willow Ave	From International Ave to Copper Ave	New	2,625	$341,300
P-21b	12" Water Main in Peach Ave	From International Ave to Copper Ave	New	2,665	$346,500
P-22	16" Water Main in Future Arterial	From International Ave to Copper Ave	New	2,650	$392,200
Northeast Village					
P-52b	12" Water Main in Future Arterial	From Future Collector to Alluvial Ave	New	4,650	$604,500
P-53	12" Water Main in McCall Ave	From Herndon Ave to Alluvial Ave	New	2,500	$325,000
P-54	12" Water Main in Thompson Ave	From Herndon Ave to Future Arterial	New	4,875	$633,800
P-55	12" Water Main in Alluvial Ave	From Thompson Ave to McCall Ave	New	2,400	$312,000
P-56	12" Water Main in Herndon Ave	From Thompson Ave to Constellation Ave	New	3,650	$474,500
P-60	16" Water Main in Future Arterial	From Future Collector to Future Collector	New	1,775	$262,700
P-61	12" Water Main in Future Arterial	From Future Arterial to Future Collector	New	2,525	$328,300
P-62	12" Water Main in Future Collector	From Future Arterial to Future Arterial	New	5,350	$695,500
P-63	12" Water Main in Future Arterial	From Future Collector to Alluvial Ave	New	4,650	$604,500
P-64	12" Water Main in Alluvial Ave	From McCall Ave to Future Collector	New	8,400	$1,092,000
P-65	12" Water Main in Future Collector	From Locust Ave to Future Collector	New	5,650	$734,500
P-66	12" Water Main in Future Collector	From Locust Ave to Alluvial Ave	New	1,500	$195,000
P-67	12" Water Main in Future Collector	From Locust Ave to Alluvial Ave	New	1,500	$195,000
P-68	12" Water Main in Future Collector	From Future Collector to Future Collector	New	5,425	$705,300
P-69	12" Water Main in Future Collector	From Future Collector to Future Arterial	New	2,025	$263,300
P-70	16" Water Main in Future Collector	From Future Collector to Future Arterial	New	2,000	$296,000
P-71	12" Water Main in Future Arterial	From Future Collector to Future Collector	New	5,300	$689,000
P-72	24" Water Main in Future Arterial	From Future Collector to CA-168	New	2,500	$480,000
P-75	30" Water Main in CA-168	From Friant-Kern Canal to Future Arterial	New	2,000	$612,000
P-76	24" Water Main in Future Arterial	From CA-168 to Future Collector	New	1,975	$379,200

Item No.	Description	Limits	Replace or New	Length (ft)	Cost
P-77	16" Water Main in Future Arterial	From Future Collector to Future Collector	New	4,700	$695,600
P-78	12" Water Main in Future Arterial	From Future Collector to Future Arterial	New	4,000	$520,000
P-79	24" Water Main in Future ROW	From CA-168 to Future Collector	New	4,200	$806,400
P-80	24" Water Main in Future ROW	From Future Collector to Future Collector	New	5,075	$974,400
P-81	12" Water Main in Future Arterial	From CA-168 to 2,000' n/o CA-168	New	2,175	$282,800
P-82	16" Water Main in Future Collector	From Future Arterial to Friant-Kern Canal	New	3,150	$466,200
P-83	12" Water Main in Future Collector	From Future Arterial to Friant-Kern Canal	New	1,725	$224,300
P-84	12" Water Main in Future Arterial	From Future Arterial to 1,600' e/o Future Arterial	New	1,575	$204,800
P-85	16" Water Main in Future ROW	From Future Collector to Future Arterial	New	3,250	$481,000
P-86	12" Water Main in Future Collector	From Friant-Kern Canal to 1,300' e/o Friant-Kern Canal	New	1,300	$169,000
P-87	16" Water Main in Future Collector	From 1,300' e/o Friant-Kern Canal to Future Arterial	New	4,075	$603,100
P-88	16" Water Main in Future Collector	From Friant-Kern Canal to Future Arterial	New	1,875	$277,500
P-89	12" Water Main in Future Arterial	From 2,000' s/o Future Collector to Future Collector	New	2,125	$276,300
P-90	12" Water Main in Future Arterial	From Future Collector to Future Collector	New	4,100	$533,000
P-91	12" Water Main in Future Arterial	From Future Collector to Future ROW	New	4,175	$542,800
P-92	12" Water Main in Future Arterial	From Future ROW to 1,600 e/o Future Arterial	New	1,500	$195,000
P-93	12" Water Main in Future ROW	From Future Arterial to Future ROW	New	1,800	$234,000
P-94	12" Water Main in Future Collector	From Future Arterial to Future ROW	New	3,875	$503,800
P-95	12" Water Main in Future Collector	From Future Arterial to Future ROW	New	1,600	$208,000
P-96	12" Water Main in Future ROW	From Future Collector to Future ROW	New	6,625	$861,300
P-97	12" Water Main in Future ROW	From Future ROW to Future ROW	New	4,725	$614,300
T-8	3 MG Tank at Future Collector e/o Friant-Kern Canal[1]		New		$6,438,000
PS-T8	4900 gpm Pump Station at Future Collector e/o Friant-Kern Canal[1]		New		$719,622
PRV1	10" PRV at Future Arterial and Thompson Ave		New		$225,000
			Phase 4 (2040-2080) Subtotal	**156,390**	**$29,341,122**

Notes:
1. Improvements are required before developing east or north of Zone 4 pressure boundary.