City of Fresno

Metropolitan Water Resources Management Plan

Phase 2 Development and Evaluation of Future Water Supply Plan

Final Draft

January 2011

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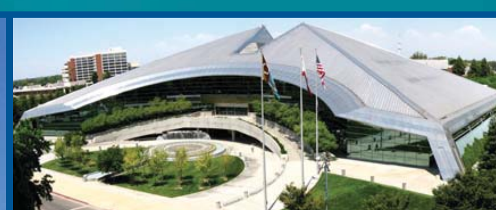

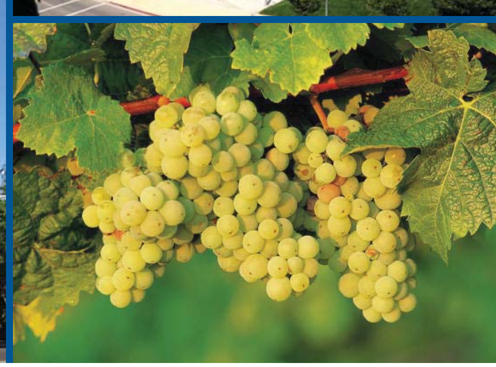

CITY OF FRESNO
METROPOLITAN WATER RESOURCES MANAGEMENT PLAN

PHASE 2 DEVELOPMENT AND EVALUATION OF FUTURE WATER SUPPLY PLAN

Prepared for

City of Fresno

January 2011

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ACKNOWLEDGEMENTS

This Phase 2 Report for the City of Fresno's Metropolitan Water Resources Management Plan Update (Metro Plan Update) represents a significant work effort and an important milestone by the City's Water Division and consultant team. The completed Metro Plan Update will facilitate future water resources management, operations decisions, and capital improvement project planning.

West Yost Associates wishes to express our appreciation to the following City staff members who made significant contributions to the development of this Metro Plan Update Phase 2 Report:

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EXECUTIVE SUMMARY

PURPOSE OF METRO PLAN UPDATE

The purpose of this City of Fresno (City) Metropolitan Water Resources Management Plan Update (Metro Plan Update) and corresponding Water Supply Plan is to update and refine the 1996 Fresno Metropolitan Water Resources Management Plan (1996 Metro Plan), taking into consideration available new data and conditions and accommodating physical and institutional changes which have occurred since the 1996 Metro Plan was prepared. The completed Metro Plan Update will facilitate future water resources management, operations decisions, and capital improvement project planning, and will assist in satisfying eligibility requirements for State funding.

The Metro Plan Update is being conducted in four phases. The four phases are described as follows:

- Phase 1 of the Metro Plan Update provided a baseline characterization of the City's water system and its ability to meet current and projected future demands. Phase 1 was completed in December 2007.
- Phase 2, as described in this report, identifies a refined future water supply plan, including identification of required supply sources and required infrastructure to meet the demands of existing and future customers through buildout of the adopted 2025 General Plan, and evaluates the potential to serve additional growth within the City's Sphere of Influence (SOI), beyond that specified in the City's adopted 2025 General Plan.
- Phase 3 involves the development of an implementation plan for the refined future water supply plan, including development of a funding plan and an institutional plan.
- Phase 4 involves preparation of environmental documentation for the Metro Plan Update and corresponding Water Supply Plan as required by the California Environmental Quality Act (CEQA).

PHASE 2 OBJECTIVES

Several issues were identified in Phase 1 of this Metro Plan Update which have been addressed in this Phase 2 Report. The following objectives provided the basis for the refined future water supply plan described in this Phase 2 Report:

- Diversify the City's future water supply to enhance overall water supply reliability;
- More aggressive conjunctive use of available water supplies to maximize use of available surface water supplies, and use of the groundwater basin in a sustainable manner which minimizes or eliminates groundwater overdraft and groundwater quality degradation;

- Evaluate potential increased surface water treatment capability, including expansion of the City's existing Northeast SWTF and construction of a new Southeast SWTF to take greater advantage of current and future available surface water supplies;
- Evaluate the potential implementation of new and expanded water conservation measures to further reduce existing and projected water demands;
- Incorporate new water supply elements such as water recycling to add to the City's water supply portfolio; and
- Evaluate and pursue, if appropriate, new water supply opportunities when they arise to increase the diversity and reliability of the City's water supply portfolio.

REVISED PLANNING ASSUMPTIONS FOR PHASE 2

In the 1996 Metro Plan, and in the Metro Plan Update Phase 1 Report, the City's future growth potential was assumed to occur as a result of an expansion of the City's Sphere of Influence (SOI). In the Phase 1 Report, this future development area outside the City's currently defined SOI, primarily extending to the southwest and the southeast of the existing SOI, was referred to as the 2060 Growth Fringe. However, since the completion of the Phase 1 Report, the City's future planning philosophy has changed from a traditional suburban development strategy to a more compact and concentrated development strategy contained within the City's existing SOI, consisting of activity centers and intensity corridors located in strategic areas of the City.

With the City's new planning focus within the SOI, the 2060 Growth Fringe described in the Phase 1 Report will no longer be considered or evaluated in this Metro Plan Update. Therefore, the assumed study area for the remainder of this Metro Plan Update will be the City's SOI, as defined in the City's adopted 2025 General Plan.

Furthermore, projected future water demands within the City's SOI have been revised to reflect refined development plans for the City's Southeast Growth Area (SEGA). The buildout of the SEGA area will likely not occur until 2040 or later, but to be conservative, the SEGA demand has been included in the City's projected 2025 demands. These revised projected demands are described in Chapter 2 of this Phase 2 Report.

RECOMMENDED FUTURE WATER SUPPLY PLAN

Future Water Supply Plan Objectives and Goals

The overall objective of the City's future water supply plan is to provide sustainable and reliable water supplies to meet the demands of existing and future customers through buildout of the General Plan in 2025.

The overall goals of the City's future water supply plan are to:

- Maximize use of available surface water supplies for direct treatment and use, and intentional groundwater recharge;

- Balance the City's groundwater operations by 2025 (corresponding with buildout of General Plan);
- Replenish groundwater basin storage when surplus surface water supplies are available;
- Continue to implement and expand demand management/water conservation measures in compliance with the City's USBR contract and to achieve specific water conservation goals; and
- Incorporate tertiary-treated recycled water into its future water supply portfolio to meet non-potable demands in new development areas and existing parts of the City to offset potable water demands.

Implementation of the City's future water supply plan will result in a significant shift and increase in diversity in the City's water supply mix, which will enhance the City's overall water supply reliability. Figure ES-1 shows the City's current and projected future supply mix based on the future water supply plan. In 2009, the City met demand by using 88 percent groundwater and 12 percent treated surface water. By 2025, with increased surface water treatment capacity and the introduction of recycled water supplies, groundwater will make up 36 percent of the City's supply, treated surface water will make up 53 percent, and recycled water will make up the remaining 11 percent.

Future Water Supply Plan Components

To meet the City's overall objectives and goals, the recommended future water supply plan for the City includes the following key components:

- Completion of the on-going residential water metering program by no later than March 2013;
- Implementation of additional water conservation measures;
- Balanced use of local groundwater resources such that, ultimately, the City's annual groundwater pumpage would essentially be equivalent to the annual recharge;
- Maximized use of available surface water either through treatment and direct use and/or intentional groundwater recharge;
- Use of recycled water to meet landscape irrigation and/or other non-potable demands in new development areas, and existing landscaped areas throughout the City to offset potable water demands; and
- Acquisition of future new supplies to increase the diversity and reliability of the City's water supply portfolio.

Table ES-1 provides a summary of the specific objectives, goals, and policies for each of these future water supply plan components.

Table ES-1. Specific Objectives, Goals and Policies for the City's Future Water Supply Plan

Future Water Supply Plan Component	Specific Objectives	Specific Goals	Specific Policies
Water Conservation (see Chapter 4)	• Make water conservation a part of everyday life for all residents and businesses in Fresno, not just something that is mandated in dry years • Continue to implement and expand demand management/water conservation measures in compliance with the City's USBR contract and to achieve specific water conservation goals • Reduce existing and future demands through more aggressive water conservation measures	• Complete residential water metering program as soon as possible (no later than March 2013); • Reduce per capita residential water use by 10 percent by March 2013 (as a result of water metering); • Further reduce overall per capita water use through implementation of expanded and additional water conservation measures: ▪ By 2010, reduce overall water use by an additional 5 percent (to about 278 gpcd); and ▪ By 2020, reduce overall water use by an additional 5 percent (total 10 percent) (to about 243 gpcd).	• Implement a tiered water rate structure as soon as possible to further encourage water conservation; • Require new development to offset a portion of their required supply needs by implementing conservation measures (anticipated to provide a 5 percent demand reduction); • Establish aggressive water conservation goals/policies for new construction; • Establish more efficient exterior water use goals/policies for existing users including water conservation measures specifically geared towards reducing water use for landscape and turf irrigation; • Provide additional staff and program-specific financial resources required to implement and manage conservation programs (e.g., grant writer, CII conservation representative); • Maintain compliance with CVP Contract including the BMP requirements; and • Update the City's UWMP every five years per State requirements.
Groundwater (see Chapter 5)	• Balance the City's groundwater pumpage with annual intentional recharge to minimize further groundwater level declines and potential water quality degradation • Maintain adequate groundwater pumping capacity and system redundancy and reliability to meet demands during dry periods and emergencies, when surface water supplies may be reduced due to climatic conditions • Implement a local groundwater banking program to allow for banking of surplus available water supplies in wet years, and later extraction in dry years	• Balance the City's impact on groundwater basin storage by 2025 (e.g., City's recharge equal to City's pumpage); • Assist regional stakeholders in restoring groundwater levels; and • Maximize intentional groundwater recharge, using available, remaining surface water supplies (e.g., surface water supplies not required for direct treatment and use).	• Balance the City's annual groundwater pumping to not exceed intentional recharge + natural inflow + subsurface inflow; • Replenish groundwater basin storage through intentional recharge when surface water supplies are available to help restore groundwater levels to historical levels; • Work with FID and FMFCD to expand existing and/or construct additional recharge basins and maintain them to take advantage of available surface water supplies; • Construct, operate and maintain dedicated intentional recharge facilities; • Consider the development of an Aquifer Storage and Recovery (ASR) System in lieu of or in addition to new recharge basins; a feasibility study will be required to identify the regulatory issues and potential challenges in obtaining approval and implementing such a system; • Require new development to mitigate for groundwater impacts (both quantity and quality); • Further develop partnerships with FID, Clovis, and others to maximize available water resources; • Provide additional staff and program-specific financial resources required to implement, manage and maintain groundwater recharge program (e.g., environmental compliance manager); • Develop a City-wide groundwater quality management plan (to maintain and monitor present and future contaminant plume management and cleanup activities); • Support the elimination of point sources for groundwater contamination (e.g., nitrate); and • Enforce the existing sewer ordinance requiring all new connections to be sewered (to eliminate potential new point contamination sources).
Surface Water (see Chapter 6)	• Increase conjunctive use of available supplies • Increase use of available supplies for treatment and direct use • Use of any additional available supplies for intentional groundwater recharge and/or groundwater banking to help achieve groundwater basin storage stabilization and replenishment	• Construct improvements to existing Northeast Surface Water Treatment Facility (SWTF) located in the northeast part of the City to achieve 30 mgd capacity as soon as possible; • Construct a new 80 mgd SWTF in the southeast part of the City by 2015; • Expand the existing Northeast SWTF by 30 mgd (to 60 mgd) by 2020; • Consider the future construction of a new Southwest SWTF (possibly 10 to 20 mgd).	• Maximize use of available surface water supplies for direct potable use and intentional groundwater recharge; • Construct, operate and maintain dedicated intentional recharge facility(s) to take advantage of available surface water supplies, integrating concepts of regional and open space uses; • Work cooperatively with FID to optimize water allocations to the City, including construction of infrastructure and conducting exchanges; • Review and update the 1976 cooperative agreement with FID on an as-needed basis; • Work cooperatively with FMFCD to improve recharge basin operational efficiency and increase number of basins available for intentional recharge; • Further develop partnerships with FID, Clovis, and others to maximize available water resources; • Provide additional staff and program-specific financial resources required to implement, manage and operate surface water use program (e.g., water resource manager); • Initiate active participation in Federal, State, regional, and local water planning and management organizations, activities, legislative activities, grant opportunities, etc; and. • Monitor and pursue opportunities to acquire additional water supplies.
Recycled Water (see Chapter 7)	• Increase the use of recycled water to help offset existing and future non-potable water demands • Maximize the use of available recycled water exchange supply contractually available from the 1976 FID agreement	• Provide 25,000 af/yr of recycled water by 2025 for landscape irrigation and other non-potable uses to offset potable water uses.	• Require new developments City-wide to install purple pipe to provide recycled water for non-potable use on parks, common areas, roadway medians, etc.; • Look for opportunities to install purple pipe near existing landscaped areas (e.g., parks, sports fields) (i.e., "piggyback" on other pipeline installation/replacement projects); • Work with FID and/or others to develop an agreement to better use the percolated treated effluent from the wastewater treatment plant; • Further develop partnerships with FID, Clovis, and others to maximize available water resources; • Allow new development to create "new" supplies by participation in the implementation of recycled water facilities and projects; • Adopt and implement the Recycled Water Master Plan; and • Provide additional staff and program-specific financial resources required to implement, manage and operate the recycled water use program.
Future New Supply (see Chapter 8)	• Consider water conservation as an additional water supply source, by reducing projected future demands and the need for future new water supplies • Evaluate and, if appropriate, pursue and acquire new surface water supply sources to increase the diversity and reliability of the City's water supply portfolio • Implement a groundwater banking program	• Because the quantity and timing of future new water supplies is uncertain at this time, no specific goals for the acquisition of new water supplies can be established at this time; • The need for and timing of future new water supplies should be assessed once future growth plans beyond buildout of the 2025 General Plan are determined	• Consider the development and implementation of new water conservation programs to reduce projected future demand, thus reducing the need for future new supplies; • Initiate/continue discussions with FID regarding water allocations to the City; • Continue to track opportunities to participate in Temperance Flat Dam and/or other new supply projects; • Consider implementing a groundwater management program; • Require new development projects to participate in efforts to fund and bring new, reliable supplies to the City; and • Further develop partnerships with FID, Clovis, and others (including those outside the region) to maximize available water resources.

Figure ES-2 shows the basic components of the City's future water supply plan in relation to the City's projected future demands, by year, through the year 2025. As shown, the City's future water supply plan includes the following major components:

- Completion of the on-going residential water metering program by no later than March 2013 and additional water conservation measures including:
  - Rebate programs for water conserving devices and systems
  - Commercial, Industrial, and Institutional water conservation programs
  - Joining the California Urban Water Conservation Council (CUWCC) and participating in informational and training workshops and jointly-funded water conservation programs
  - Retrofit Upon Resale Ordinance
  - Turf Replacement Rebates ("Cash for Grass")
  - Landscape Water Audit and Budget Program
  - Prioritized Leak Detection Program
  - Complete Water System Audit
  - Billing with Commodity Rates (and eventually Tiered Rates)
- Reduction in annual groundwater use and maintenance of existing intentional groundwater recharge quantities to achieve and maintain balanced groundwater operations; increased recharge capacity (20,500 af/yr additional) through the increased use of existing recharge facilities and construction and maintenance of new recharge facilities (about 340 acres of additional recharge area) to allow for increased recharge in years when surplus surface water is available to help restore groundwater levels to historical levels; as described in Chapter 5, additional intentional groundwater recharge may be achieved through the construction of expanded or new recharge basins and/or the development of an Aquifer Storage and Recovery (ASR) Well System.
- Increased surface water treatment capacity
  - Completion of operational improvements at the existing Northeast Surface Water Treatment Facility (SWTF) to provide for 30-mgd treatment capacity
  - Construction of a new Southeast SWTF with a design capacity of 80 mgd by 2015
  - Expansion of the existing Northeast SWTF by 30 mgd to 60 mgd (design capacity) by 2020
  - As noted in Chapter 6, the City may also wish to consider the future construction of a new Southwest SWTF (perhaps a plant with a treatment capacity of 10 to 20 mgd) in the southwestern part of the City to provide added flexibility for serving future demands in that portion of the City.
- Introduction of recycled water supply for landscape irrigation and other non-potable uses to offset potable water demands
  - Use of North Fresno Wastewater Reclamation Facility (WRF) to irrigate Copper River Golf Course (initially 750 af/yr, increasing to 1,000 af/yr by 2015)

  - Use of up to 25,000 af/yr of recycled water for landscape irrigation and other non-potable uses in new development areas and existing parts of the City by 2025 (highly treated recycled water to be produced at new satellite plants, stand-alone plants and/or an expanded Regional Wastewater Reclamation Facility (RWRF))

- Acquisition of a new water supply source in the future to increase the diversity and reliability of the City's water supply portfolio; as discussed in Chapter 8, this additional water supply may be the result of additional water conservation programs and/or acquisition of new water supplies

The City's overall future water supply plan is described in Chapter 3 of this Phase 2 Report, and each of the water supply components is described in further detail in the subsequent chapters of this Phase 2 Report.

BENEFITS OF THE FUTURE WATER SUPPLY PLAN ON THE GROUNDWATER BASIN

For this Phase 2 evaluation, WRIME used the Kings Basin Integrated Groundwater Surface Water Model (Kings IGSM) groundwater model developed for the Upper Kings Basin Water Forum, Kings River Conservation District and the City of Fresno (previously described in Chapter 7 of the Phase 1 Report) to perform a focused evaluation of the effects of the City's proposed water supply plan (as described in this Phase 2 Report) on future groundwater levels and groundwater storage underlying the Fresno Metro Plan SOI.

For the Phase 2 groundwater model runs, WRIME incorporated increasing demand projections, combined with assumed annual variations in hydrologic conditions (based on historical hydrologic patterns), to predict the groundwater response (change in groundwater levels and storage) for both "baseline" (without the proposed project) and "with project" (with the proposed project, e.g., implementation of the City's proposed water supply plan) conditions. Although WRIME's evaluation was based on the planning assumptions and demand projections described in the Phase 1 Report (and not on the revised assumptions used in this Phase 2 Report), the results of WRIME's evaluation are still applicable and demonstrative of the relative anticipated responses of the underlying groundwater basin within the City's SOI under "baseline" and "with project" conditions. WRIME's modeling results are summarized in Chapter 5 of this Phase 2 Report. A complete description of the groundwater model assumptions, runs and results is provided in Appendix D of this Phase 2 Report

The overall results of the WRIME groundwater modeling indicate that the City's future water supply plan, as described in this Phase 2 Report, will have significant beneficial impacts to the groundwater basin underlying the City (e.g., increased groundwater levels and storage). Under "with project" conditions, including reduced dependence on groundwater pumpage to meet existing and future demands, increased surface water treatment capacity, and increased groundwater recharge, groundwater levels underneath the Fresno SOI increase by as much as 40 feet as compared to 2005 conditions (see Figure ES-3), thus eliminating the existing cone of depression under the Fresno SOI.

If the City continues to meet existing and increased demands primarily using groundwater (continued use of existing water supply sources, or “status quo” operations), WRIME’s groundwater modeling indicates that water levels would continue to decline and, on average, would decline up to an additional 85 feet below 2005 conditions (see Figure ES-4).

Such a drop in groundwater levels would have a devastating impact on the City’s groundwater production wells. As described in Chapter 5, in 2025 under “baseline” conditions, 26 percent of the City’s wells (69 wells) would have groundwater levels below the current pump bowl intake elevations and would not be operational, and another 13 percent of the wells (36 wells) would have groundwater levels of 15 feet or less above the pump bowl elevations, indicating that when those wells are turned on and water levels in the well are drawn down, there may be inadequate water in the well to maintain adequate water coverage over the top of the pump bowl. This is graphically shown on Figure ES-5 where the wells with groundwater levels below the current pump bowl elevations are shown in “red.”

Figure ES-6 shows the change in simulated groundwater levels at 2060 for the “with project” condition as compared to the “baseline” status quo condition. As shown, throughout the SOI area, simulated groundwater levels are significantly higher for the “with project” conditions, as compared to “baseline” conditions. In the center of the Fresno SOI, groundwater levels are up to 105 feet higher under the “with project” condition. These increases in groundwater levels are a direct result of implementing the future water supply plan, and the benefits of this plan are further demonstrated in hydrographs for key well locations within the SOI (see Figures ES-7a and ES-7b and additional information in Appendix D).

As described in Chapter 5, in 2025 under “with project” conditions, only 3 percent of the City’s wells (8 wells) would have groundwater levels below the current pump bowl elevations, and another 6 percent of the wells (16 wells) would have groundwater levels of 15 feet or less above the pump bowl elevations.

PLAN FLEXIBILITY TO SERVE FUTURE GROWTH BEYOND BUILDOUT OF THE 2025 GENERAL PLAN

Ability to Serve Additional Future Population

As described in Chapter 2, the City has a finite quantity of available water based on the City’s SOI, and the recommended backbone infrastructure described in this Metro Plan Update has been sized to deliver those available water supplies to customers within the City’s SOI. However, with a finite water supply within the City’s SOI, the only way to serve additional growth within the City’s SOI would be to acquire a new source of supply (as described in Chapter 8 of this Phase 2 Report) and/or to use the available water supplies more efficiently. As described in Chapter 8, acquisition of new water supplies will be a challenging undertaking due to water supply conditions in California. While new supplies may become available to the City in the future, they are likely to be in limited quantities at relatively high cost. Therefore, the more likely source of new supply to the City in the future is a more efficient use of the City’s existing water supplies.

The number of people that can be served with a finite supply of water is based on the average per capita water use within the City. At the Metro Plan Update per capita water use goal of 243 gpcd, the available water supply in dry years[1] of 236,200 af/yr is sufficient to serve approximately 868,000 people, which is adequate to serve the anticipated City population through 2025.

However, with the City's proposed development of Activity Centers and Intensity Corridors within the SOI (described in Chapter 2), if the population grows beyond 868,000 people within the SOI, as is projected by COG, the average per capita water use in the City would have to be reduced to serve the additional population. For example, with a dry year supply of 236,200 af/yr, and the COG projected population for 2035 of 961,366 people, the City's average annual per capita water use would need to be reduced to and sustained at about 220 gpcd (a 10 percent reduction from the 243 gpcd Metro Plan Update goal). Similarly, for a projected population of 1 million people, the City's average annual per capita water use would need to be reduced further and sustained at about 210 gpcd (a 14 percent reduction from the 243 gpcd Metro Plan Update goal).

While this additional reduction in per capita water use may be attainable to provide for additional growth within the SOI, it will require the City to adopt and enforce aggressive land use and sustainable water use policies for new development and very aggressive water conservation measures to further reduce the City's average per capita water use below that targeted in this Metro Plan Update.

Flexibility of Recommended Backbone Infrastructure

It is understood that the locations of the City's proposed activity centers and intensity corridors may be revised and change over time as new development plans are developed. The infrastructure plan contained in this Metro Plan Update is designed to provide the City with a solid framework of backbone water system transmission and distribution infrastructure throughout the City's service area. Additional improvements to specific facilities serving specific new developments may be required to meet localized water system operations criteria and City design standards. However, the recommended backbone infrastructure has sufficient flexibility to meet these future needs.

PLAN IMPLEMENTATION

Implementation Timeline

Implementation of the City's future water supply plan will be a complex and costly undertaking. Figure ES-8 shows the timing of the major components of the proposed water supply plan from 2008 until 2025. As shown, extensive planning, design and construction activities will be required in the next 10 to 15 years to meet the anticipated demands associated with buildout of the 2025 General Plan and ensure a sustainable and reliable water supply for the future. As

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[1] The water supply available in dry years is being used here to ensure that adequate supplies are available in dry years without requiring additional water conservation beyond that assumed to achieve the 243 gpcd per capita water use. In critically dry years (critical high or critical low), additional mandated water conservation may be required.

shown, planning, acquisition of property and other activities must begin immediately to ensure that the required infrastructure components are in place and operational to meet the anticipated demands associated with buildout of the 2025 General Plan and to assure that the City's objective of balancing groundwater operations by 2025 can be achieved by reducing groundwater pumpage to stop groundwater declines and begin to restore groundwater levels to historical levels.

Phase 3 of the Metro Plan Update will provide more information and details on the specific implementation of the City's future water supply plan, including an evaluation of funding options and institutional issues.

Required Infrastructure and Estimated Costs

Chapter 9 of this Phase 2 Report describes the infrastructure required to implement the City's proposed future water supply plan. Required infrastructure components include the following:

- Surface water treatment facilities;
- Groundwater production and treatment facilities;
- Potable water storage, transmission and distribution system facilities;
- Recycled water treatment, storage, and distribution system facilities; and
- Groundwater recharge facilities.

Table ES-2 lists the major infrastructure improvements required to implement the City's future water supply plan. Detailed descriptions of the required improvements are provided in Chapter 9.

The required new facilities to implement the City's future water supply plan are shown on Figure ES-9 (potable water facilities) and are further described in Chapter 9.

Table ES-3 summarizes the estimated capital costs for the City's future water supply plan. A detailed discussion of the assumptions used to develop these estimated capital costs is provided in Chapter 9.

Table ES-2. Major Infrastructure Improvements Required to Implement City's Future Water Supply Plan

Infrastructure Component	Description
Surface Water Treatment & Treated Water Storage	Existing Northeast SWTF • Expansion of existing Northeast SWTF to total design capacity of 60 mgd • New 5.0 MG clearwell (in addition to existing 1.5 MG clearwell) New Southeast SWTF • New Southeast SWTF with total design capacity of 80 mgd • New 6.0 MG clearwell Future Southwest SWTF • Possibly 10 to 20 mgd
Potable Water System Regional Transmission & TGM System	Extensive new potable water transmission and distribution system pipelines to distribute treated surface water supplies from the SWTFs to customers
Potable Water Storage	New potable water storage facilities located at key locations in the City to provide operational flexibility during peak demand periods and provide emergency storage capacity • New clearwells at SWTFs (see above) • New Southeast Tank "T2" (approximately 2 million gallons) (next to existing 2 million gallon Southeast Tank "T1" near Clovis Avenue and California Avenue) (already budgeted by City and funded through other revenue sources/accounts) • New Southeast Tank "T3" (approximately 3 million gallons) adjacent to interim packaged SWTF (already designed; already budgeted by the City and funded through other revenue sources/accounts) • New Downtown Tank "T4" (3 million gallons) (currently being designed; already budgeted by the City and funded through other revenue sources/accounts) • New Eastside Tank "T5" (assumed to be 4 million gallons) (possibly near Chestnut Avenue and Ashlan Avenue) (capacity and location to be confirmed in the Water Master Plan) • New Westside Tank "T6" (assumed to be 4 million gallons) (near Highway 99 at Ashlan Avenue) (capacity and location to be confirmed in the Water Master Plan)
Groundwater Production	New wells to meet increasing peak hour demand within the SOI • 65 new wells by 2025
Groundwater Treatment	Groundwater treatment systems on new wells as needed to address organic and inorganic water quality contaminants
Recycled Water Treatment	Improvements to the existing RWRF and construction of satellite and/or stand-alone WWTFs to produce tertiary treated recycled water for non-potable uses including landscape irrigation to offset potable water demands (to be determined in the Recycled Water Master Plan)
Recycled Water Storage	Recycled water storage facilities to serve peak demands (to be determined in the Recycled Water Master Plan)
Recycled Water Regional Transmission & TGM System	Extensive new recycled water transmission and distribution system pipelines to distribute recycled water supplies from the RWRF/WWTFs to customers (to be determined in the Recycled Water Master Plan)
Groundwater Recharge Facilities	Expanded existing groundwater recharge basins and/or new groundwater recharge basins/areas (340 acres of additional recharge area; 425 acres total including roadways and setbacks) to increase intentional groundwater recharge capabilities, particularly in years when surplus surface water supplies are available for recharge Potential Aquifer Storage and Recovery (ASR) System for groundwater injection and extraction in lieu of or in addition to new recharge basins

Table ES-3. Estimate of Probable Capital Cost of Required Infrastructure to Support Future Water Supply Plan[(a)]

Item Description	Total Cost to 2025, million dollars[(b)]
Surface Water Treatment	396.6
Potable Water System Regional Transmission	174.1
Potable Water TGM System	151.8
Potable Water Storage[(c)]	50.3
Groundwater Production	51.0
Groundwater Treatment[(d)]	104.7
Recycled Water Treatment, Storage and Regional Transmission and TGM System	--[(e)]
Groundwater Recharge Facilities	127.5
Total Estimated Project Cost	$1,056

(a) Costs do not include Renewal and Replacement (R&R) costs for the City's existing infrastructure.
(b) Based on a May 2010 ENR 20 Cities Construction Cost Index of 8762. All costs include construction contingency, engineering, construction management, and program implementation costs, estimated to be 50 percent, as documented in the Phase 1 Report.
(c) Includes Tanks "T2", "T3", "T4", "T5" and "T6".
(d) Includes treatment for a number of existing and future City wells. Assumes GAC treatment for TCP removal for 40 of the City's existing wells; however, this is a preliminary estimate that has a significant level of uncertainty because of the limited data that is currently available from operating TCP treatment facilities. Assumes GAC and ion exchange treatment for future wells for other potential contaminants of concern.
(e) To be determined in the Recycled Water Master Plan.

A summary of the estimated operations and maintenance (O&M) costs for the year 2025, in present dollars, is provided in Table ES-4.

Table ES-4. Estimate of Probable O&M Cost of Required Infrastructure to Support Future Water Supply Plan at Year 2025

Item Description	Estimated Annual O&M Cost at Year 2025, million dollars[(a)]
Surface Water Treatment	25.7
Groundwater Production	2.9
Groundwater Treatment	11.7
Recycled Water Treatment and Storage	--[(b)]
Groundwater Recharge Facilities	0.5
Total Estimated Annual O&M Cost	$40.8

(a) Present dollars.
(b) To be determined in the Recycled Water Master Plan.

The recommended infrastructure and estimated capital and O&M costs presented in Tables ES-3 and ES-4, and as described in Chapter 9, represent the facilities required to implement the City's future Water Supply Plan, as described in this Phase 2 Report, through buildout of the City's 2025 General Plan. As shown, the estimated total capital costs for these facilities are significant and will require an extensive effort by the City to finance the completion of all required improvements, including adjustments to both water rates and UGM fees. However, the City now has a "road map" for the development of an integrated Water Supply Plan which will meet the water supply needs of existing and future customers.

As described in Chapter 5, due to the continuing, significant groundwater level declines, storage depletion, and continuing groundwater quality problems, the City has no other recourse but to develop and implement portions of the recommended Water Supply Plan in a phased and prioritized manner, to ensure the continuation of reliable water service to both existing and potential future customers.

A large portion of the estimated costs are a result of the City's transformation from primarily a system relying exclusively on groundwater wells located throughout the service area (with a rather limited service area), to a system supplied primarily by two surface water treatment facilities and the associated regional transmission system and transmission grid main (TGM) system. Although a portion of these costs are the direct result of having to serve new development, a portion of the costs should also be allocated to existing customers due to the increased system reliability and alternative source of supply to replace contaminated groundwater. Allocation of the estimated costs for the recommended infrastructure will be addressed in Phase 3 of the Metro Plan Update.

RECOMMENDED METRO PLAN UPDATE MONITORING AND CORRECTIVE ACTION PROGRAM

As important as having developed a water supply plan to meet the needs of the City's existing and future water customers is the implementation of a monitoring program to track the progress and success of the water supply plan. Chapter 10 of this Phase 2 Report describes the recommended monitoring program for the City's water supply plan to track progress and initiate a corrective action plan, if necessary, to achieve the objectives and goals of the plan.

Three key tracking parameters are recommended:

- Groundwater balance status;
- Overall per capita water use; and
- Residential water metering program progress.

These parameters will be tracked and compared with established goals on an annual basis. As discussed in Chapter 10, tracking of these parameters will allow the City to track overall progress of the water supply plan and, if needed, identify the appropriate corrective actions needed to get back on track to achieve the established objectives and goals.

Suggested triggers and corrective actions are described in Chapter 10 and include actions in the following areas:

- Management and administrative activities;
- Groundwater recharge operations;
- Water conservation activities;
- Recycled water operations; and
- Surface water treatment operations.

NEXT STEPS

Phase 3 of the Metro Plan Update will involve the development of an implementation plan for the City's future water supply plan, including development of a funding plan and institutional plan. The funding plan will evaluate prioritization of recommended water facility improvements to minimize fiscal impacts, allocate costs to existing customers and new development, and identify potential Federal, State, and local sources of funding for recommended programs and improvements.

Phase 4 of the Metro Plan Update will involve preparation of environmental documents as required by the California Environmental Quality Act (CEQA). Near-term facility improvements and action will be covered at the project level, and long-term actions will be covered at a program level.

Figure ES-1. City of Fresno Current and Future Water Supply Sources

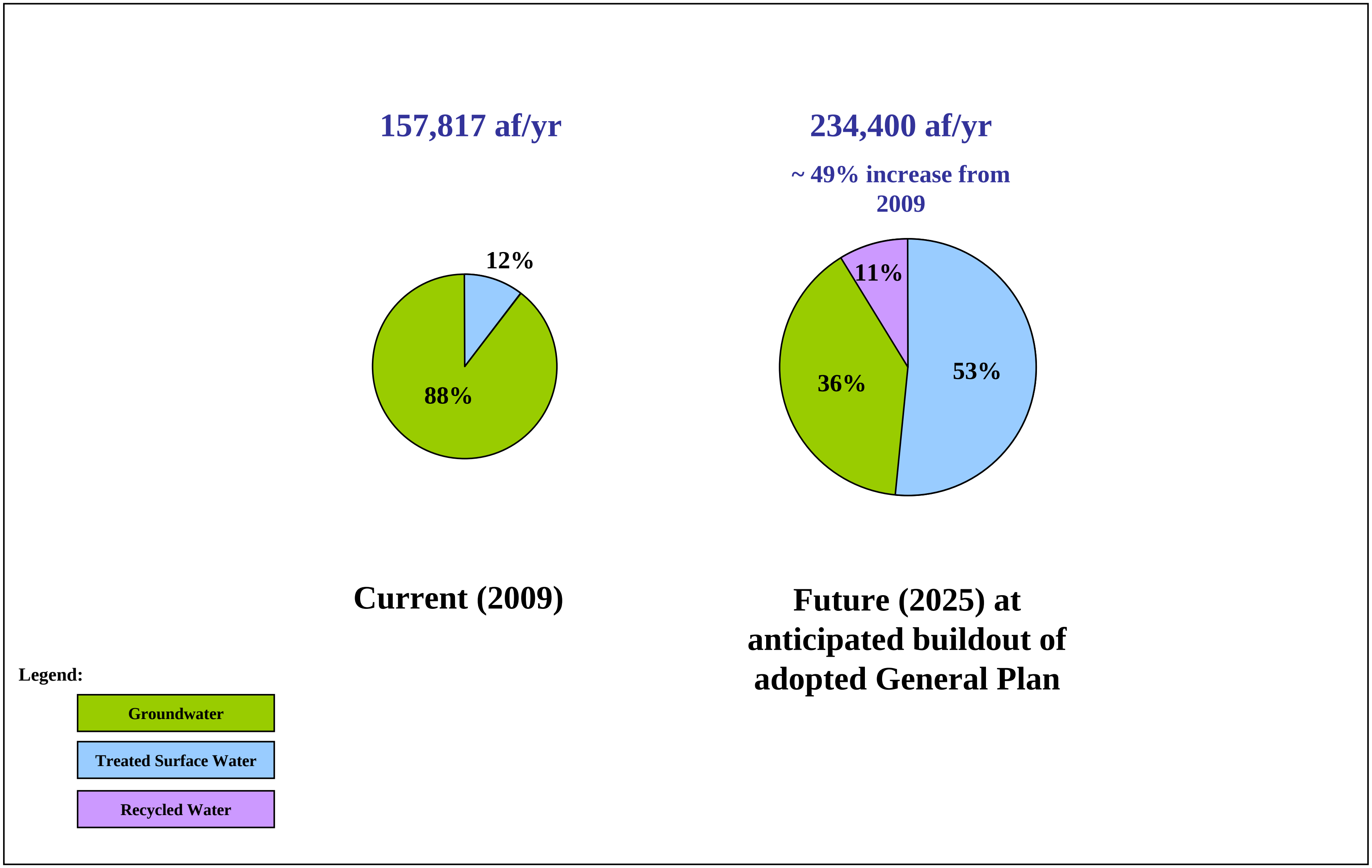
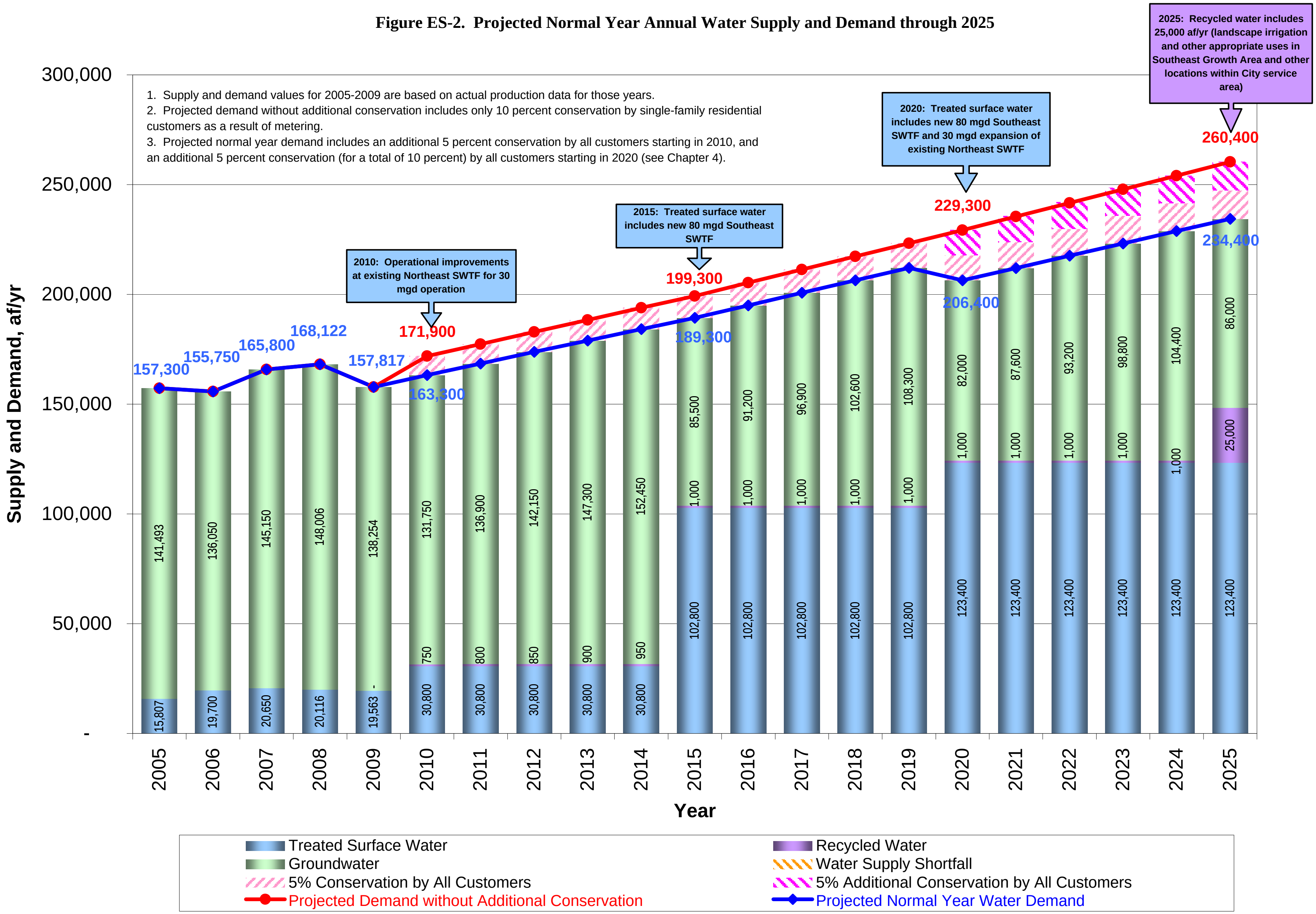


Figure ES-2. Projected Normal Year Annual Water Supply and Demand through 2025



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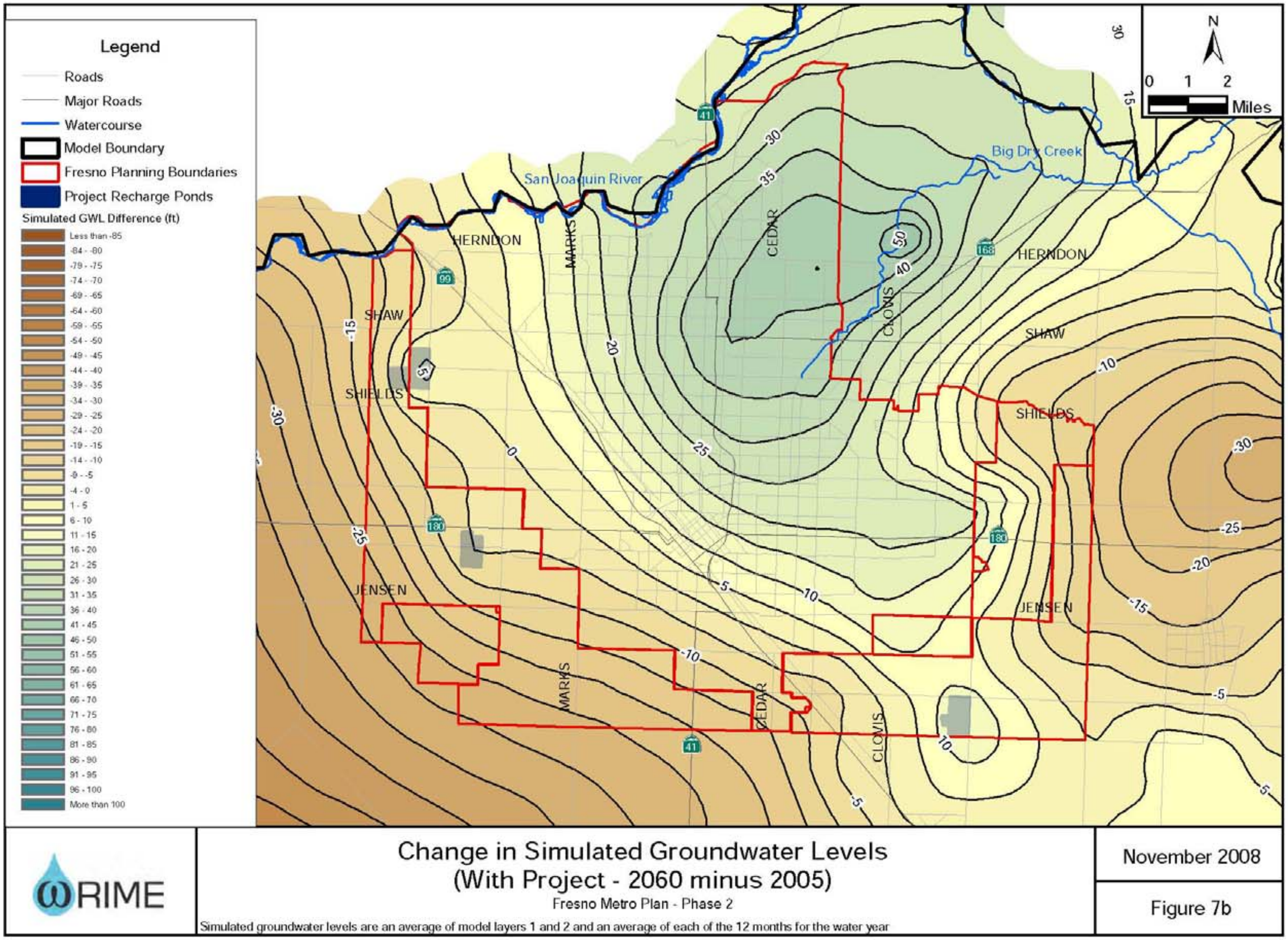

Figure ES-3. With Project Condition: Change in Simulated Groundwater Levels from 2005 to 2060

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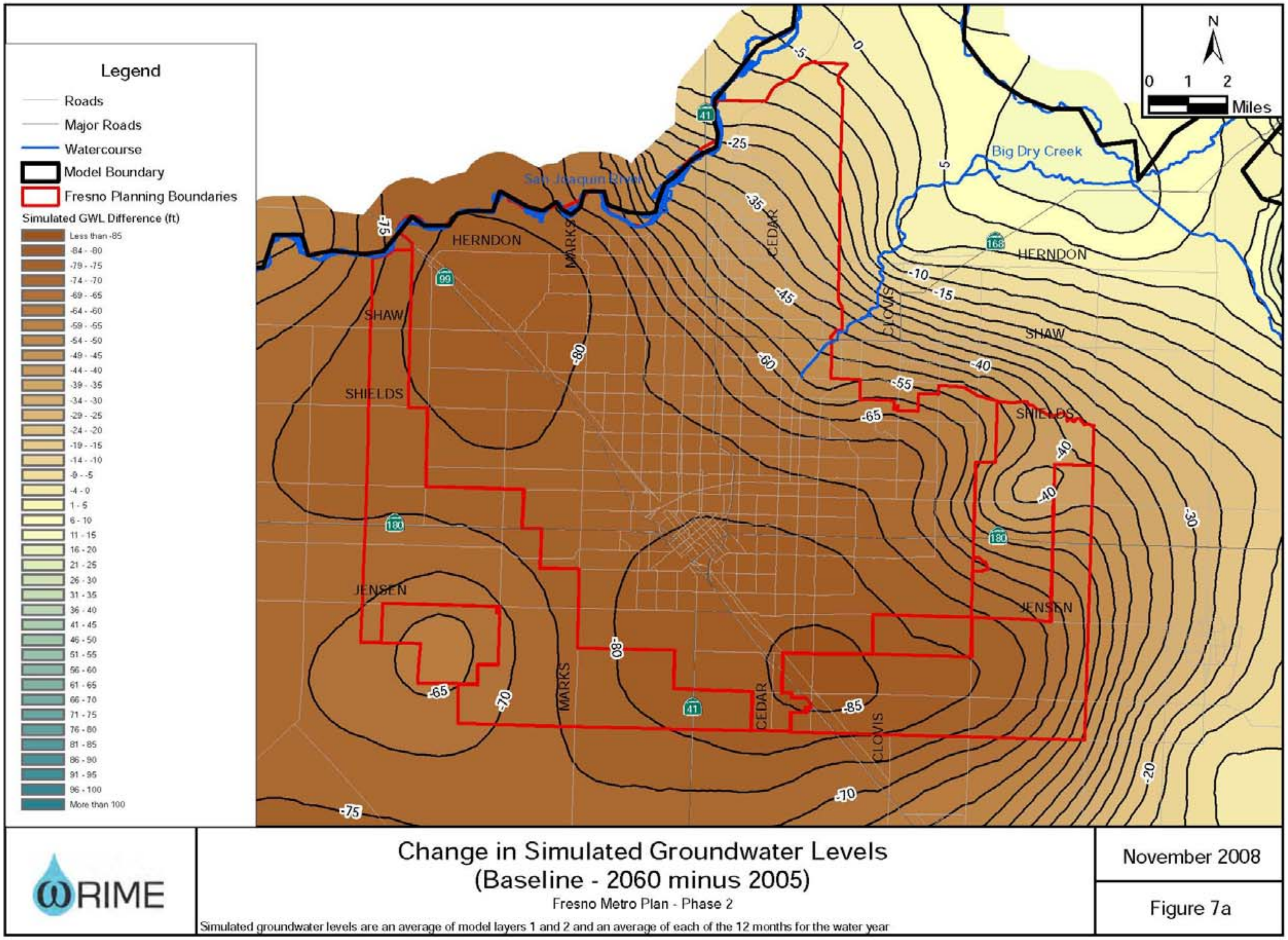

City of FRESNO

Figure ES-4. Baseline Condition: Change in Simulated Groundwater Levels from 2005 to 2060

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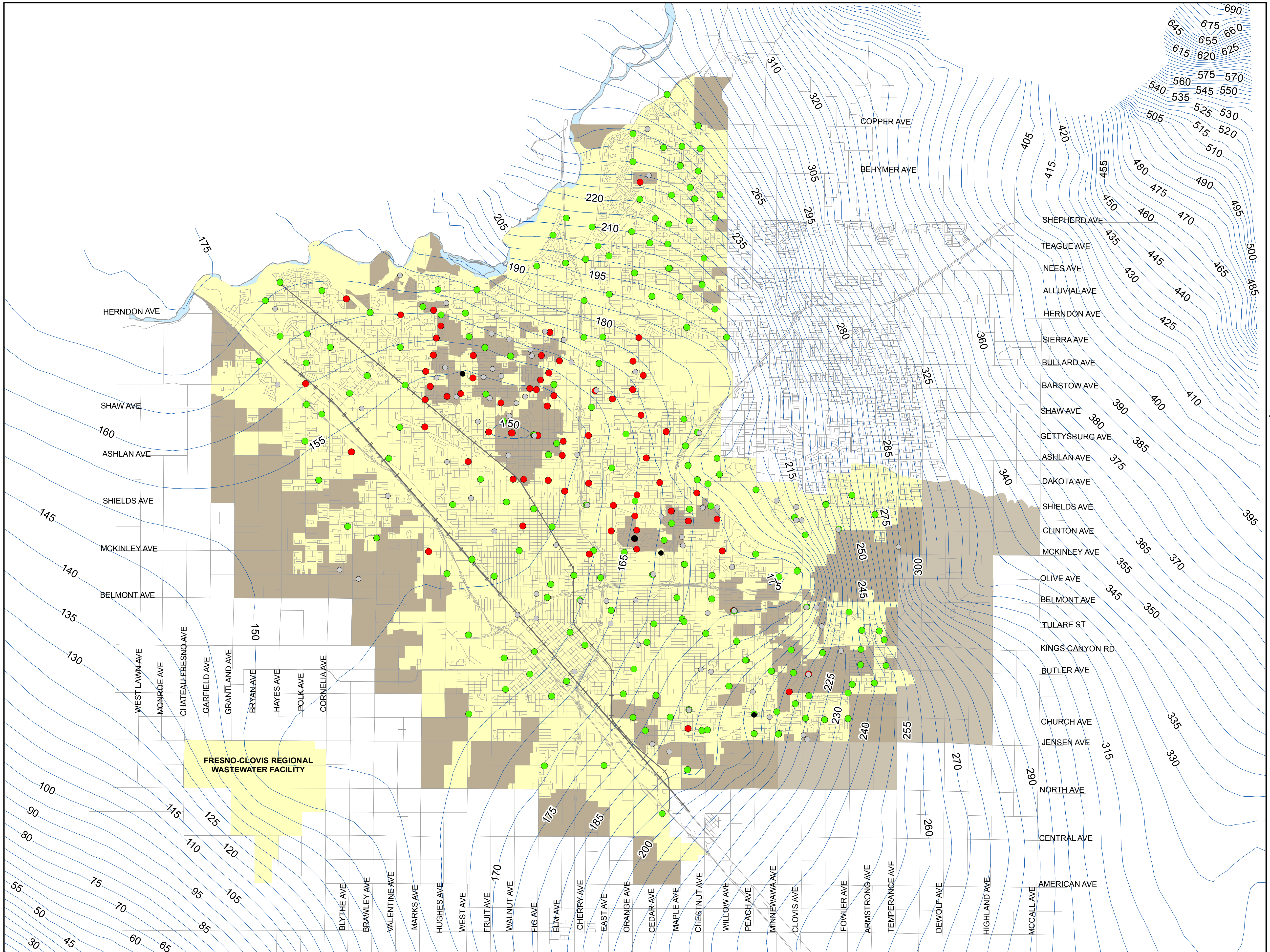
FIGURE ES-5

City of Fresno
Metro Plan Update
Phase 2 Report
2025 GROUNDWATER ELEVATION WITHOUT PROPOSED PROJECT



0 1 2
Scale in Miles

Notes
1. "No Data" indicates no depth to pump bowl information available.
2. Groundwater contours provided by WRIME for projected 2025 groundwater elevations without proposed water supply project recommended in the Metro Plan.

LEGEND

- Groundwater elevation higher than pump bowl depth
- Groundwater elevation lower than pump bowl depth
- No Data
- Not in service
- Groundwater contours (No Project 2025)
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

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Consulting Engineers

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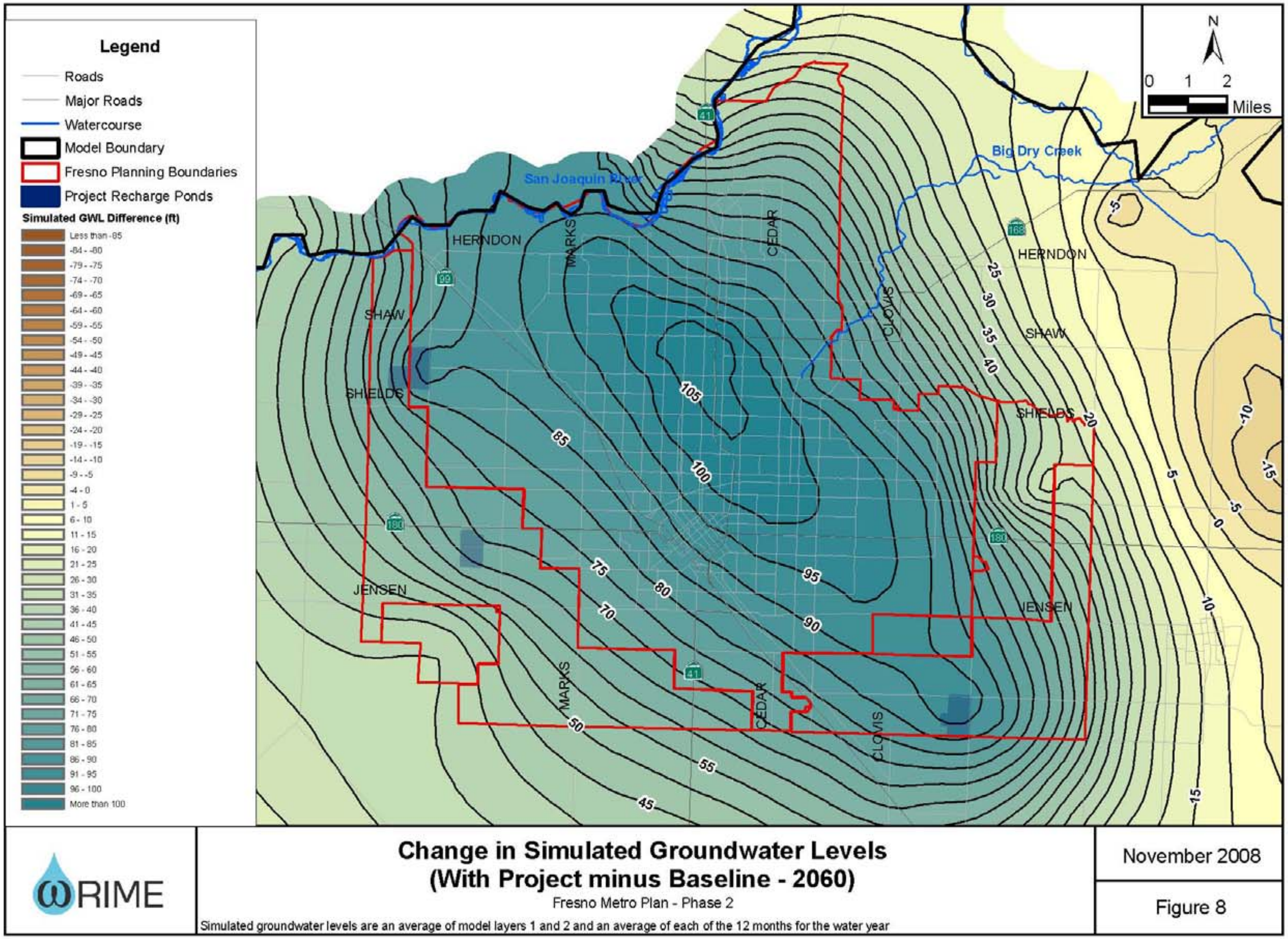
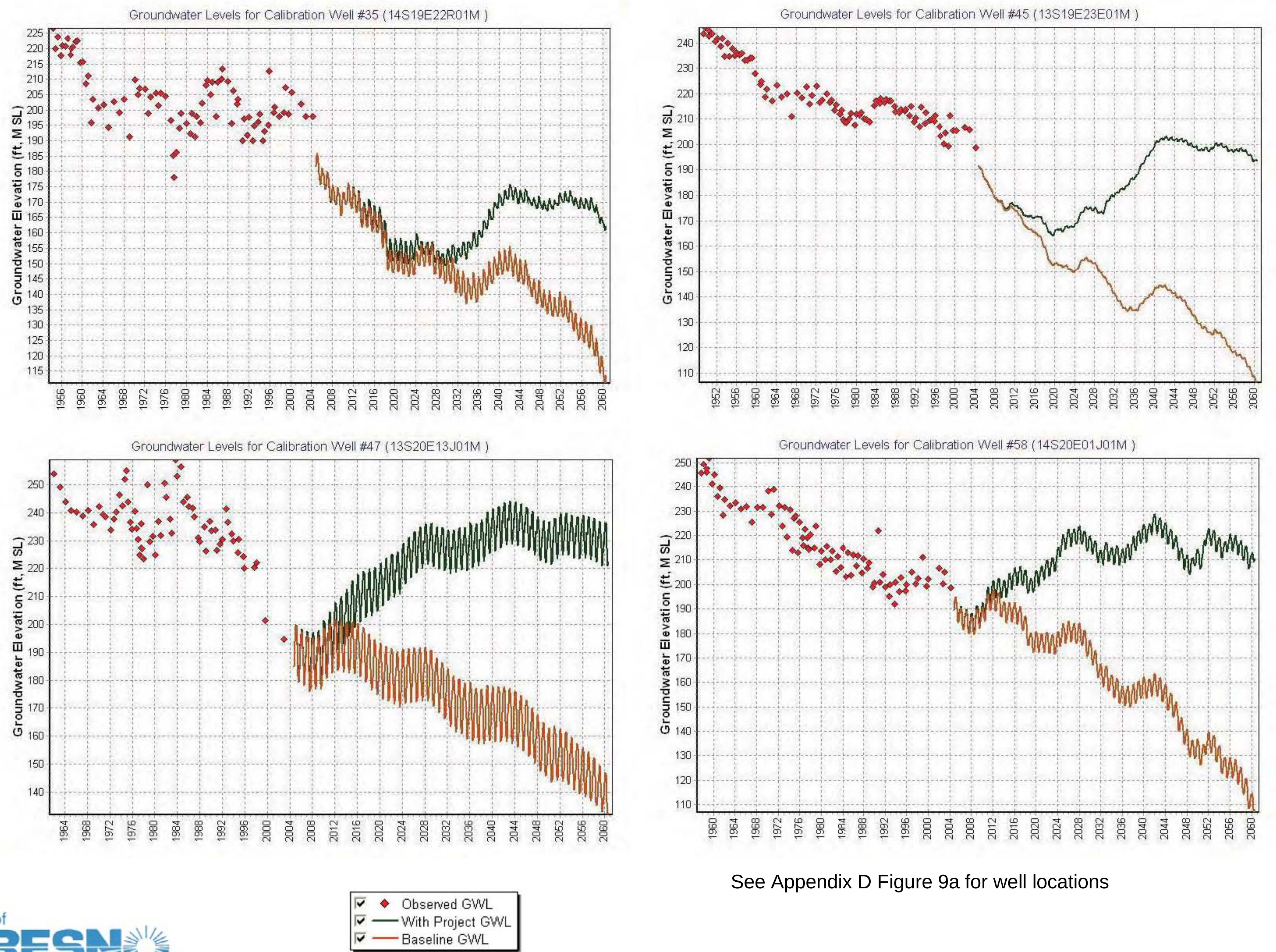


City of FRESNO

Figure ES-6. Change in Simulated Groundwater Levels in 2060 (With Project Condition – Baseline Condition)



See Appendix D Figure 9a for well locations

City of FRESNO

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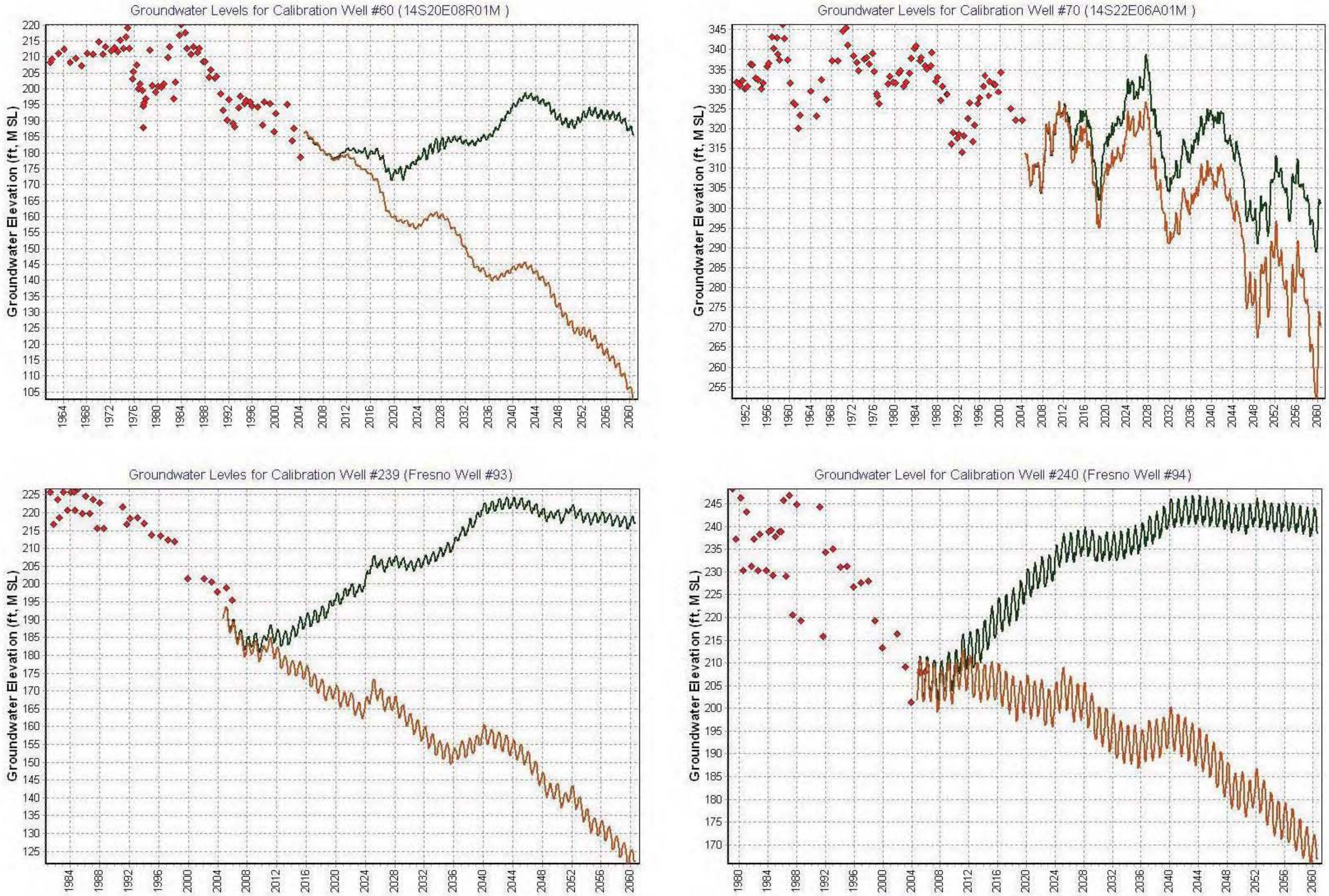
Figure ES-7a. Hydrographs for Key Wells in Fresno Sphere of Influence



See Appendix D Figure 9a for well locations

City of FRESNO

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Figure ES-7b. Hydrographs for Key Wells in Fresno Sphere of Influence

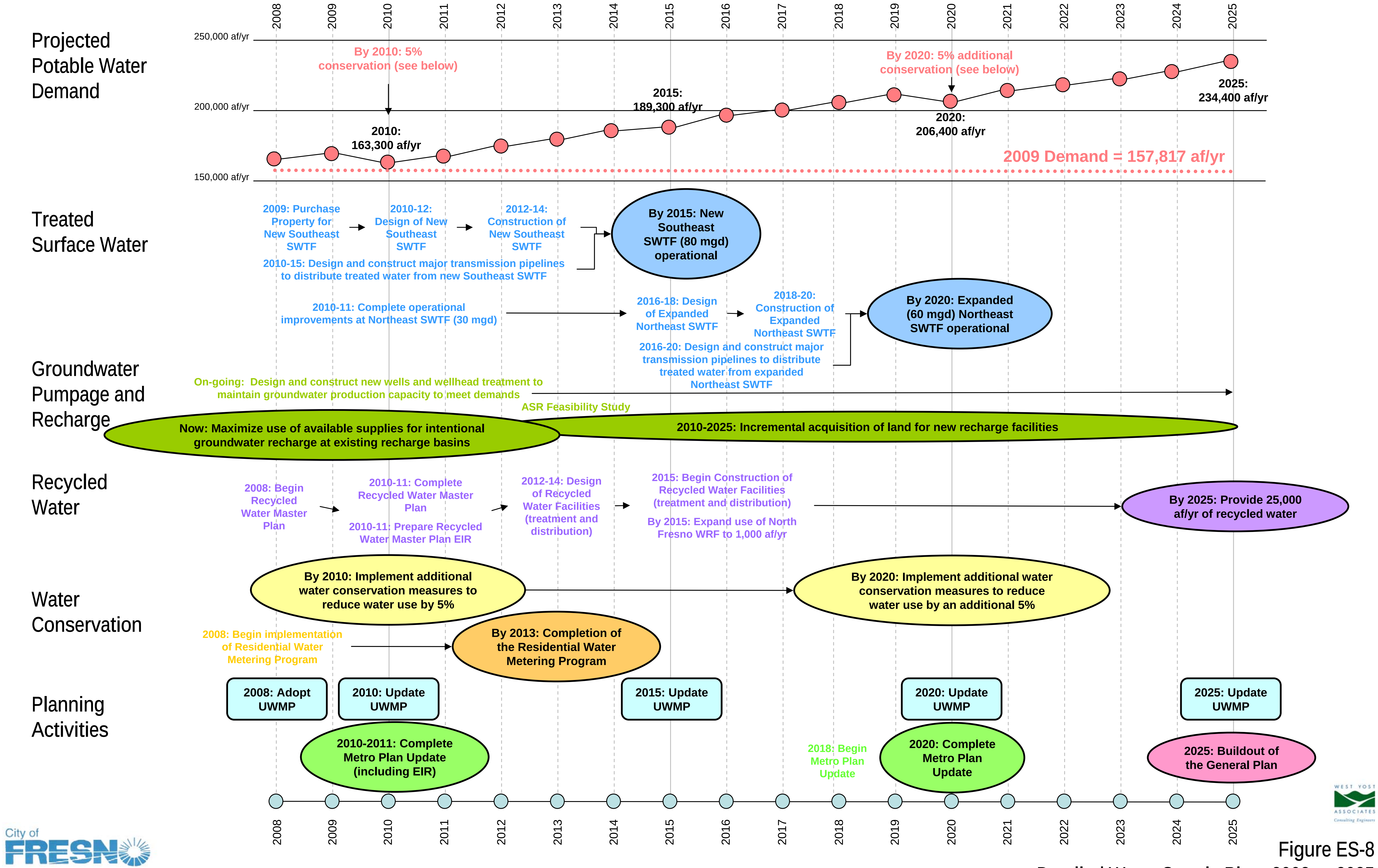

Figure ES-8
Detailed Water Supply Plan: 2008 to 2025

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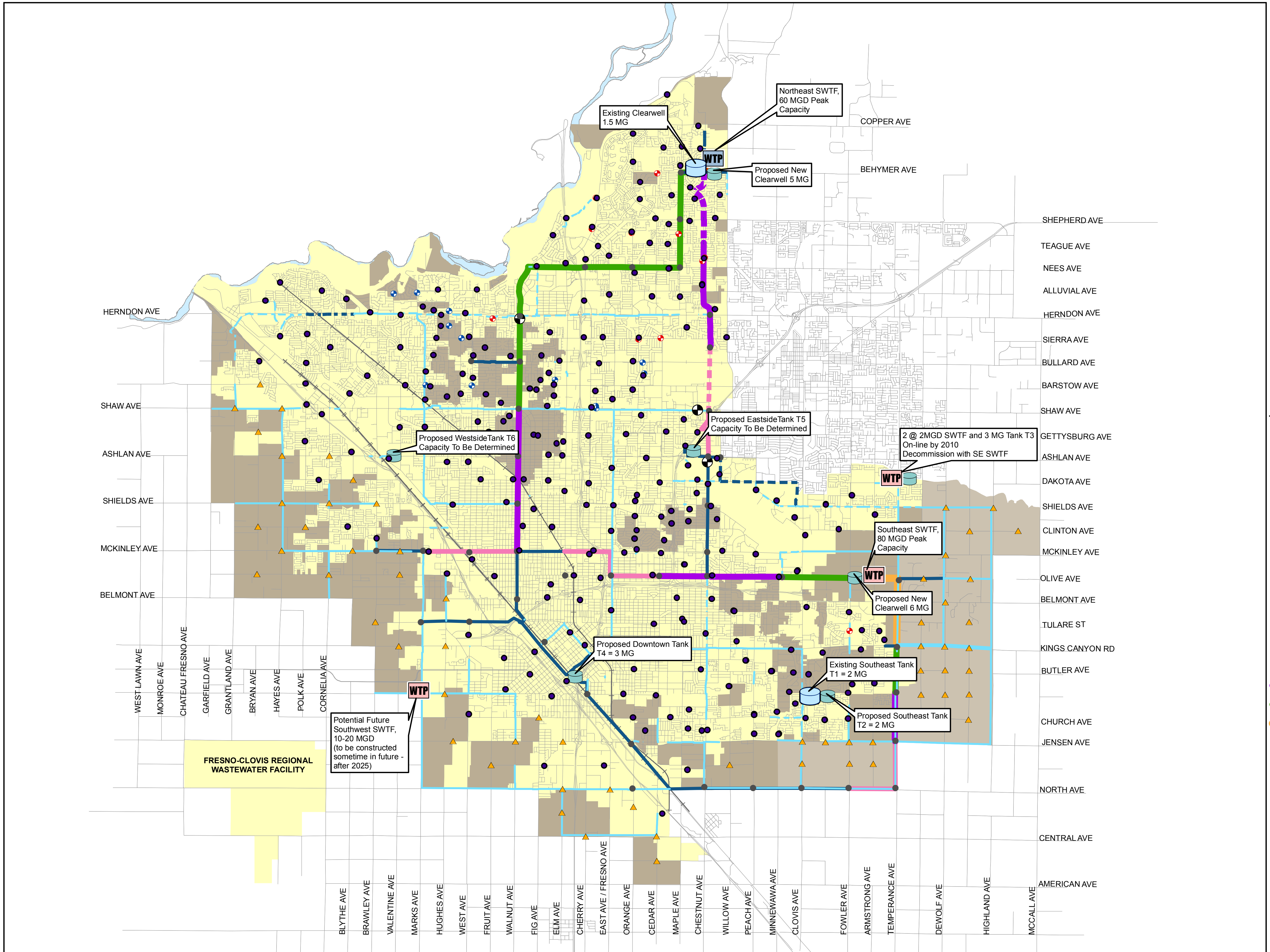
FIGURE ES-9

City of Fresno
Metro Plan Update
Phase 2 Report
2025 PROPOSED POTABLE REGIONAL AND TGM WATER INFRASTRUCTURE



N

0 1 2
Scale in Miles

Notes
1. Dashed line indicates an existing pipeline.

LEGEND

- WTP Existing Water Treatment Plant
- Proposed Tank Site
- WTP Future Water Treatment Plant
- Future Pressure Reducing Valve
- TGM Tie-in Location
- Pressure Sustaining Valve
- Fluoride District PRV
- Existing Well
- Future Well 2010-2025
- 16-inch Diameter
- 24-inch Diameter
- 30-inch Diameter
- 36-inch Diameter
- 42-inch Diameter
- 48-inch Diameter
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

WEST YOST ASSOCIATES
Consulting Engineers

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CHAPTER 1. INTRODUCTION

INTRODUCTION

This report presents the findings of Phase 2 of the Fresno Metropolitan Water Resources Management Plan Update (Metro Plan Update). The purpose of this Metro Plan Update is to update and refine the 1996 Fresno Metropolitan Water Resources Management Plan (1996 Metro Plan), taking into consideration available new data and conditions, and accommodating physical and institutional changes which have occurred since the 1996 Metro Plan was prepared. The completed Metro Plan Update will facilitate future water resources management, operational decisions, and capital improvement planning, and will assist in satisfying eligibility requirements for State funding.

Phase 1 Overview and Recommendations

Phase 1 provided a baseline characterization of the City of Fresno (City) water system and its ability to meet current and projected future water demands. This characterization was documented in the Final Phase 1 Report dated December 2007. During Phase 1 of this Metro Plan Update, it was assumed that the City would continue to operate at "status quo" (i.e., meeting future water demands using only the existing Northeast Surface Water Treatment Facility and local groundwater supplies), assuming no modifications to its existing water system. As discussed in the Phase 1 Report, with groundwater levels already declining, each year the City continues to operate in this mode will continue to accelerate groundwater level declines in the basin, possibly effecting groundwater quality, and further impacting the availability, reliability and sustainability of the City's groundwater resources.

Phase 2 Focus Areas

Phase 2 of the Metro Plan Update was developed to address these issues by identifying alternative and/or new water system and operational changes that will allow the City to become more "sustainable" with respect to its water resources and better use its available water supplies. Specific issues that have been evaluated in Phase 2 of the Metro Plan Update include:

- Water supply diversification to enhance overall water supply reliability and sustainability;
- More aggressive conjunctive use of available water supplies to make maximum use of available surface water supplies, and use of the groundwater basin in a balanced, sustainable manner which minimizes or eliminates groundwater overdraft and groundwater quality degradation;
- Further evaluation of increased surface water treatment capability, including expansion of the City's existing Northeast SWTF and a new surface water treatment facility in the southeastern portion of the City, to take greater advantage of current and future available surface water supplies;

- Implementation of new and expanded water conservation measures to further reduce existing and projected water demands;
- Incorporation of new water supply elements such as water recycling to add to the City's water supply portfolio;
- Evaluation and, if appropriate, pursuit of new water supply opportunities when they arise to increase the diversity and reliability of the City's water supply portfolio; and
- Implementation of a local groundwater banking program to store surplus surface water supplies available in wet years, for later extraction and use in dry years.

Changes to Metro Plan Update Planning Assumptions

Since the completion of the Phase 1 Report, the City's has focused their planning efforts within the City's Sphere of Influence (SOI) boundary, as defined in the City's adopted 2025 General Plan. Current development trends throughout the State have changed from predominantly suburban expansion to more concentrated and compact, and energy and water efficient, development within the City's core area. The City's Downtown revitalization efforts and associated infrastructure improvements are a prime example of this trend. The City's Planning Department is beginning to prepare an update of the City's General Plan which, instead of assuming a lateral expansion of the SOI, will include the development of a network of concentrated and intensified activity centers and corridors located in strategic areas within the City's SOI boundary.

As such, to ensure that the Metro Plan Update is consistent with the City's current planning direction and assumptions, the assumed growth area beyond the SOI boundary (referred to as the 2060 Growth Fringe in the Phase 1 Report) will not be evaluated in this Phase 2 Report. Instead, this Phase 2 Report focuses on buildout of the SOI as defined in the 2025 General Plan, and the potential to serve additional growth within the City's SOI boundary, beyond that specified in the City's adopted 2025 General Plan. These revised planning assumptions, and their implications to the Metro Plan Update, are described in Chapter 2 of this Phase 2 Report.

CONTENTS AND ORGANIZATION OF THIS PHASE 2 REPORT

This Metro Plan Update Phase 2 Report (Phase 2 Report) details the findings of the work prepared by the project team during Phase 2 of the Metro Plan Update. The chapter organization is listed below.

- Chapter 1: Introduction
- Chapter 2: Revised Planning Assumptions and Water Demand Projections
- Chapter 3: Future Water Supply Plan
- Chapter 4: Future Additional Water Conservation Measures
- Chapter 5: Future Groundwater
- Chapter 6: Future Treated Surface Water

- Chapter 7: Future Recycled Water
- Chapter 8: Future New Water Supply Sources
- Chapter 9: Required Infrastructure to Support Future Water Supply Plan
- Chapter 10: Recommended Metro Plan Update Monitoring and Corrective Action Program

Appendices to this Phase 2 Report are listed below.

- Appendix A: Surface Water Treatment Facility Siting Study
- Appendix B: Technical Memoranda by Carollo Engineers Related to Recycled Water, Treatment Requirements, and Treatment Costs
- Appendix C: Supporting Documentation Related to Groundwater Recharge Operations
- Appendix D: Future Groundwater Response (groundwater modeling work by WRIME)
- Appendix E: Potential Impacts of Status Quo Operations on Future Well Operations
- Appendix F: Recycled Water Survey

NEXT STEPS

Phase 3 of the Metro Plan Update will include final refinements to the recommended future water supply plan and development of an institutional plan, funding plan, and implementation schedule. Phase 4 of the Metro Plan Update will consist of the preparation of an Environmental Impact Report (EIR) for the recommended plan. In the EIR, required near-term facility improvements and actions will be evaluated at a "project" level, and required long-term improvements and actions will be evaluated at a "program" level.

CHAPTER 2. REVISED PLANNING ASSUMPTIONS AND WATER DEMAND PROJECTIONS

INTRODUCTION

In the 1996 Metro Plan, and in the Metro Plan Update Phase 1 Report, the City's future growth potential was assumed to occur as a result of an expansion of the City's Sphere of Influence (SOI). In the Phase 1 Report, this future development area outside the City's currently defined SOI, primarily extending to the southwest and the southeast of the existing SOI, was referred to as the 2060 Growth Fringe.

However, since the completion of the Phase 1 Report, the City's future planning philosophy has changed from a traditional suburban development strategy to a more compact and concentrated development strategy within the City's SOI, consisting of activity centers and intensity corridors located in strategic areas of the City. To address this new development philosophy, the City's Planning Department is embarking on an update of the City's General Plan to account for this new planning philosophy through 2035. The General Plan Update is anticipated to be completed in October 2012 and will include policies to promote energy, water efficient development and sustainable use of available resources.

The purpose of this chapter is to describe changes to the City's future buildout assumptions and conditions which have occurred since the completion of the Phase 1 Report, including changes to the assumed study area and revised population estimates within the City's SOI, and their impact on the future water demand projections included in this Metro Plan Update. While this Metro Plan Update focuses on buildout of the SOI as defined in the 2025 General Plan, the potential to serve additional growth within the City's SOI boundary, beyond that specified in the City's adopted 2025 General Plan, is also described in this chapter.

REVISED METRO PLAN UPDATE STUDY AREA

As described above, in the 1996 Metro Plan, and in the Metro Plan Update Phase 1 Report, the City's future growth potential beyond buildout of the 2025 General Plan was assumed to occur in the area outside the City's currently defined SOI. In the Metro Plan Update Phase 1 Report this future development area was referred to as the 2060 Growth Fringe (see Figure 3-1 in the Phase 1 Report).

With the City's new planning focus within the SOI, the 2060 Growth Fringe described in the Phase 1 Report will no longer be considered or evaluated in this Metro Plan Update. Therefore, the assumed study area for the remainder of this Metro Plan Update will be the City's SOI, as defined in the City's adopted 2025 General Plan (see Figure 2-1). The ability to serve additional growth beyond buildout of the 2025 General Plan, within the proposed activity centers and intensity corridors being considered for the proposed General Plan Update (see Figure 2-2), is discussed later in this chapter.

REVISED POPULATION ESTIMATES

The City's projected population within the SOI was described in Chapter 3 of the Metro Plan Update Phase 1 Report. Population projections for buildout of the SOI in 2025 were described as follows:

- 2025 General Plan Buildout Estimate
  - Population @ 2025 = 790,955
  - Assumes a 2 percent annual growth rate
- Water Division Estimate
  - Population @ 2025 = 692,202
  - Assumes a 1.9 percent annual growth rate (consistent with the growth rate assumed by the Council of Fresno County Governments, COG)

In March 2010, COG released revised population forecasts for the City's SOI based on the latest Fresno County population projection approved by the Council of Fresno County Governments Policy Board for use in their transportation model and air quality conformity analysis. The previous and revised population projections are shown in Table 2-1:

Table 2-1. Future Population Projections for City of Fresno

	2010	2015	2020	2025	2030	2035
2025 General Plan Buildout				790,955		
City of Fresno Water Division Estimate[b]				692,202		
City of Fresno Population Forecast by COG[c]	624,668	693,413	761,245	826,006	888,192	961,366

(a) Assumes a 2 percent annual growth rate.
(b) Assumes a 1.9 percent annual growth rate.
(c) Source: March 30, 2010 letter from Council of Fresno County Governments to Keith Bergthold, Assistant Director, City of Fresno Planning and Development Department.

As shown, these latest COG population projections for 2025 have increased from the previous estimates. The new COG projection for 2025 is about 4 percent higher than the 2025 projection provided in the City's 2025 General Plan, and about 19 percent higher than the Water Division's 2025 population estimate. The City's ability to serve this additional population using available water supplies is discussed later in this chapter.

REVISED WATER DEMAND PROJECTIONS

Water demand projections for buildout of the City's SOI were developed in Phase 1 of the Metro Plan Update and are described in Chapter 3 of the Phase 1 Report. Water demand projections were calculated using a per capita-based methodology and a land use-based methodology. Table 2-2 provides a summary of the projected water demands that were calculated using these two methods.

Table 2-2. Summary of Phase 1 Water Demand Projections

Projection Method	Projected Water Demand in 2025, acre-feet per year, af/yr[a]
Per Capita-Based Methodology	
Low Estimate[b]	209,400
High Estimate[c]	239,200
Land Use-Based Methodology	
Low Estimate[d]	248,800
High Estimate[e]	259,300

[a] Estimates include assumed water conservation as a result of the Residential Water Metering Program. Estimates do not include the additional 10 percent conservation discussed in this Phase 2 Report (see Chapters 3 and 4).
[b] See Phase 1 Report Figure 3-11. Based on the Water Division's population projections, assuming a 1.9 percent annual growth rate.
[c] See Phase 1 Report Figure 3-11. Based on the population projections included in the City's adopted 2025 General Plan, assuming an annual growth rate of about 2.0 percent.
[d] See Phase 1 Report Figure 3-12. Does not include contingency for Bakman, CSUF, Pinedale, and private groundwater users to be served by the City.
[e] See Phase 1 Report Figure 3-12. Does include contingency for Bakman, CSUF, Pinedale, and private groundwater users to be served by the City.

To be conservative, the highest of these 2025 water demand projections (259,300 af/yr based on the high estimate using the land use-based methodology) was adopted and was used for the remainder of the Phase 1 analysis and for the City's 2008 Urban Water Management Plan (UWMP).

At the time that these projections were calculated for the Phase 1 Report, there were no firm land use plans for the Southeast Growth Area (SEGA). For purposes of projecting water demands for the SEGA project area, it was assumed that the SEGA would have a unit water use (in acre-feet per acre per year, af/ac/yr) equivalent to the average unit water use in the rest of the City. This resulted in a 2025 water demand projection for the SEGA project area of 26,800 af/yr (see Phase 1 Report Table 3-10). To be conservative, it was assumed that this demand would be met entirely with potable water.

Since the completion of the Phase 1 Report, alternative land use development plans have been developed for SEGA project area. While these development plans have not yet been finalized, they do provide for a more detailed estimation of future water demands in the SEGA area. Based on the "trend alternative", the projected total water demand at buildout is 26,400 af/yr. Based on the "preferred alternative" for the proposed SEGA project, the projected total water demand at buildout is 27,800 af/yr. Under both land use alternatives it is assumed that 5,100 af/yr of the total projected total water demand will be met using recycled water, so the potable water demands for the trend and preferred land use alternatives are 21,300 af/yr and 22,700 af/yr, respectively[1]. However, the projected total water demand for the "preferred alternative" is about 4 percent higher than the SEGA water demand included in the Phase 1 Report.

It should be noted that the proposed SEGA project, as currently envisioned, may not be fully built out until 2040 or later, significantly later than the proposed buildout of the City's 2025 General Plan. However, to be conservative and to accurately reflect the current proposed development plan within the SEGA project area, the City's overall water demand projection for 2025 has been increased to 260,400 af/yr (consistent with the SEGA "preferred alternative" water demand)[2]. This revised water demand projection for buildout of the City's 2025 General Plan will be assumed for this Phase 2 Report.

The SEGA water demand represents about 10 percent of the City's projected 2025 water demand. While this is a significant percentage of the City's total water demand, it is not a significant driver in the need for new infrastructure. The need for new infrastructure is primarily being driven by the need to diversify the use of available water supplies and balance groundwater operations to stop groundwater level declines and help restore groundwater levels to historical levels. The water supply plan contained in this Metro Plan Update is designed to be flexible to accommodate and serve the City's future development needs, including the proposed SEGA project, regardless of its timing.

FUTURE PER CAPITA WATER USE

As described in this Phase 2 Report, a major component of the City's future water supply plan is the implementation of additional water conservation programs and the reduction of per capita water use in the City. As described in Chapters 3 and 4 of this Phase 2 Report, the City's goal is to reduce overall per capita water use to 243 gallons per capita per day (gpcd) by 2020[3]. This goal was developed based on the City's implementation of the on-going Residential Water Metering Program and the implementation of additional water conservation programs, particularly those targeting the reduction of outdoor water use. This goal of 243 gpcd is about 19

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[1] Source: Technical Memorandum, Projected Potable and Non-Potable Water Demands, Wastewater Flows, and Conceptual Water Supply Plan at Buildout of the Southeast Growth Area (SEGA) Project, prepared for EDAW AECOM, prepared by West Yost Associates, February 10, 2010.

[2] See Table 3-10 of the Phase 1 Report (High Demand Estimate @ 2025). Revised Total Projected Consumption = 234,400 af/yr (233,400 af/yr + (27,800-26,800) af/yr): Revised UAFW = 26,000 af/yr; Revised Total Projected Production = 260,400 af/yr.

[3] This overall per capita water use is calculated by dividing the City's total annual potable water production by the total population served.

percent lower than the City's long-term average historical per capita water use of 300 gpcd (based on the average per capita water use from 1990 to 2009).

In response to on-going drought conditions and environmental issues in the San Joaquin Delta, in February 2008, Governor Arnold Schwarzenegger called for a statewide 20 percent reduction in per capita water use by 2020 and asked state and local agencies to develop a more aggressive plan of water conservation to achieve the goal. A team of state and federal agencies (the 20 x 2020 Agency Team) consisting of the DWR, SWRCB, California Energy Commission, Public Utilities Commission, Department of Public Health, Air Resources Board, CALFED Program, the USBR, and the CUWCC was formed to develop a statewide implementation plan for achieving this goal. Then, on November 10, 2009, Governor Arnold Schwarzenegger signed Senate Bill X7-7 (SB X7-7), one of several bills passed as part of a comprehensive set of new Delta and water policy legislation. SB X7-7 requires a statewide 20 percent reduction in urban water usage by 2020 and establishes various methodologies for urban water suppliers to establish their interim (2015) and final (2020) per capita water use targets.

Four methodologies are identified in SB X7-7 for establishing per capita water use targets. Urban water suppliers may select any one of the four methods for calculating their per capita water use targets. The methodology chosen must be documented in the 2010 UWMPs. A preliminary evaluation of these methodologies and the resulting per capita water use targets for the City is summarized in Table 2-3.

As Method 4 has not yet been developed, it is not possible to calculate a per capita water use target based on that method at this time. DWR is currently estimating that the methodology for Method 4 will be available by February 2011.

However, based on the first three methods, it would appear that the City's recommended interim 2015 target will be 282 gpcd, and the final recommended 2020 target will be 251 gpcd (per Method 1), as this method provides the City with the largest allowable per capita water use in compliance with SB X7-7. Therefore, the City's per capita water use goal of 243 gpcd by 2020 established in this Metro Plan Update complies with the per capita water use targets established by the SB X7-7 legislation.

Table 2-3. Preliminary Evaluation of SB X7-7 Per Capita Water Use Targets for City of Fresno

Method Number & Description	Key Calculations[a]	SB X7-7 Per Capita Water Use Targets
Method 1: A 20 percent reduction from historical baseline per capita water use based on a 10-year moving average per capita water use ending between December 31, 2004 and December 31, 2010.	Historical baseline per capita water use is determined to be 313 gallons per capita per day based on the 10-year period from 1996 through 2005	Interim (2015) target: 90 percent of 313 gpcd, or **282 gpcd** Final (2020) target: 80 percent of 313 gpcd, or **251 gpcd**
Method 2: Per capita water use based on 55 gallons per capita per day water use for residential water use; landscape irrigation use based on water efficiency equivalent to the standards of the Model Water Efficient Landscape Ordinance; and a 10 percent reduction from baseline commercial, industrial and institutional (CII) water use.	Residential = 55 gpcd Landscape Irrigation = 33 gpcd[b] CII = 51 gpcd Total = 139 gpcd	Interim (2015) target: **226 gpcd** (halfway between 10-year baseline and final target) Final (2020) target: **139 gpcd**
Method 3: 95 percent of the hydrologic region targets established in the per capita water use based on the April 2009 Draft 20x2020 Water Conservation Plan.	The City is located in the Tulare Lake Hydrologic Region (Region 7). The per capita water use goals for the Tulare Lake Hydrologic Region (Region 7) are as follows: • Baseline Water Use (1995-2005) = 285 gpcd • Interim Target (to be achieved by 2015) = 237 gpcd • Final Target (to be achieved by 2020) = 188 gpcd	Interim (2015) target: 246 gpcd (halfway between 10-year baseline and final target) Final (2020) target: 95 percent of 188 gpcd, or **179 gpcd**
Method 4: Method to be determined by DWR.	To be determined	To be determined

(a) The key calculations shown here are based on the City's actual historical water use, and are based on the methodologies and current understanding of the provisions described in the SB X7-7 legislation.

(b) Per capita water use estimate for landscape irrigation is based on limited data. If the City were to select this target method, additional detailed analysis would be required.

PLAN FLEXIBILITY TO SERVE FUTURE GROWTH BEYOND BUILDOUT OF THE 2025 GENERAL PLAN

Ability to Serve Additional Future Population within the City's Sphere of Influence

As described in the Phase 1 Report, each of the City's water supply components provides the City with a finite quantity of water. Available surface water supplies from FID are based on the quantity of FID-served acres which have been annexed by the City. Once the City SOI is built out, the amount of water available from FID will be limited to the amount of surface water associated with the FID acres within the City SOI, and the hydrologic conditions in any given year. Available surface water supplies are based on the City's contract with the USBR for up to 60,000 af/yr of Class 1 surface water supplies, with reduced deliveries in dry years. Available groundwater supplies are based on the natural groundwater recharge within the basin underlying the City. Additional groundwater pumpage beyond the natural recharge amount must be offset by intentional groundwater recharge to maintain balanced groundwater operations.

Table 2-4 provides a summary of available water supplies in 2025 under various hydrologic conditions. These available water supplies are shown graphically on Figure 2-3.

Table 2-4. Available Water Supply in 2025 Under Various Hydrologic Conditions

Source	Available Supply, af/yr				
	Wet Years	Normal Years	Dry Years	Critical High Dry Years	Critical Low Dry Years
FID (Kings River)[(a)]	151,800	126,500	104,000	75,400	65,600
USBR (Class 1)[(b)]	60,000	58,200	39,800	25,200	13,900
Recharge (Exchange)[(c)]	13,800	13,800	13,800	13,800	13,800
Natural Groundwater Inflow[(d)]	53,600	53,600	53,600	53,600	53,600
Recycled Water	25,000	25,000	25,000	25,000	25,000
Total Supply Available in 2025	304,200	277,100	236,200	193,000	171,900

(a) See Phase 1 Report, Table 5-8.
(b) See Phase 1 Report, Table 5-11.
(c) See Phase 1 Report, Chapter 5.
(d) See Phase 2 Report, Table 5-2.

The recommended backbone infrastructure described in this Metro Plan Update has been sized to deliver these available water supplies to customers within the City's SOI. However, with a finite water supply within the City's SOI, the only way to serve additional growth within the City's SOI would be to acquire a new source of supply (as described in Chapter 8 of this Phase 2 Report) and/or to use the available water supplies more efficiently. As described in Chapter 8, acquisition of new water supplies will be a challenging undertaking due to water supply conditions in California. While new supplies may become available to the City in the future, they are likely to be in limited quantities at relatively high cost. Therefore, the more likely source of new supply to the City in the future is a more efficient use of the City's existing water supplies.

The number of people that can be served with a finite supply of water is based on the average per capita water use within the City. As shown on Figure 2-4, at the Metro Plan Update per capita water use goal of 243 gpcd, the available water supply in dry years[4] of 236,200 af/yr is sufficient to serve approximately 868,000 people. As shown in Table 2-1, the latest COG population projection for the City for 2025 is 826,006 people. Therefore, if the average per capita water use of 243 gpcd can be achieved and maintained, there is sufficient water supply available within the City's SOI to serve the projected population.

However, if the population grows beyond 868,000 people, as is projected by COG (see Table 2-1), the average per capita water use in the City would have to be reduced to serve the additional population. For example, with a dry year supply of 236,200 af/yr, and the COG projected population for 2035 of 961,366 people, the City's average annual per capita water use would need to be reduced to and sustained at about 220 gpcd (a 10 percent reduction from the 243 gpcd Metro Plan Update goal). Similarly, for a projected population of 1 million people, the City's average annual per capita water use would need to be reduced to and sustained at about 210 gpcd (a 14 percent reduction from the 243 gpcd Metro Plan Update goal).

While this additional reduction in per capita water use may be attainable to provide for additional growth within the SOI, it will require the City to adopt and enforce aggressive land use and sustainable water use policies for new development, and very aggressive water conservation measures to further reduce the City's average per capita water use below that targeted in this Metro Plan Update.

Flexibility of Recommended Backbone Infrastructure

It is understood that the locations of the City's proposed activity centers and intensity corridors may be revised and change over time as new development plans are developed. The infrastructure plan contained in this Metro Plan Update is designed to provide the City with a solid framework of backbone water system transmission and distribution infrastructure throughout the City's service area. Additional improvements to specific facilities serving specific new developments may be required to meet localized water system operations criteria and City design standards. However, the recommended backbone infrastructure will not need to change.

[4]The water supply available in dry years is being used here to ensure that adequate supplies are available in dry years without requiring additional water conservation beyond that assumed to achieve the 243 gpcd per capita water use. In critically dry years (critical high or critical low), additional mandated water conservation may be required.

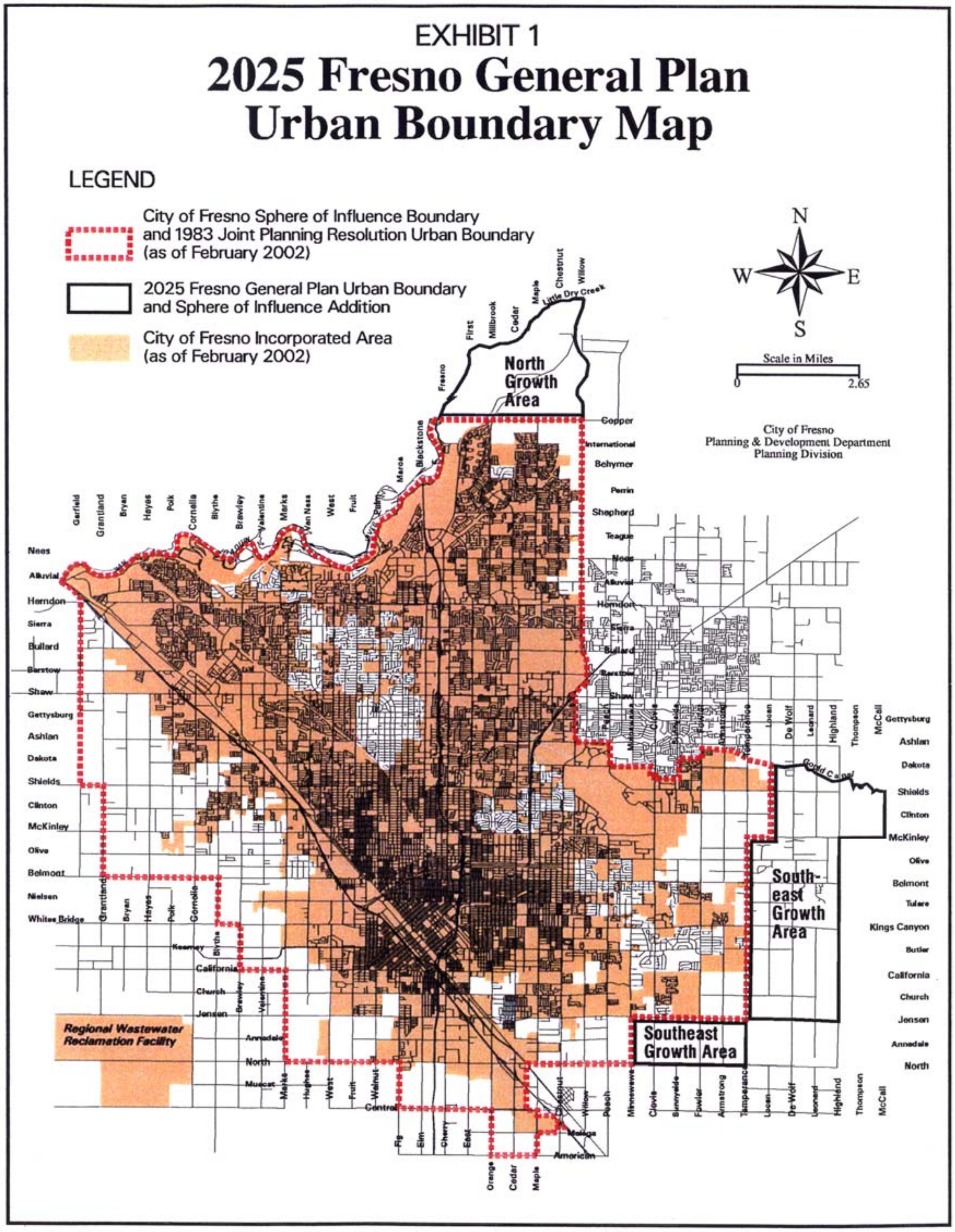
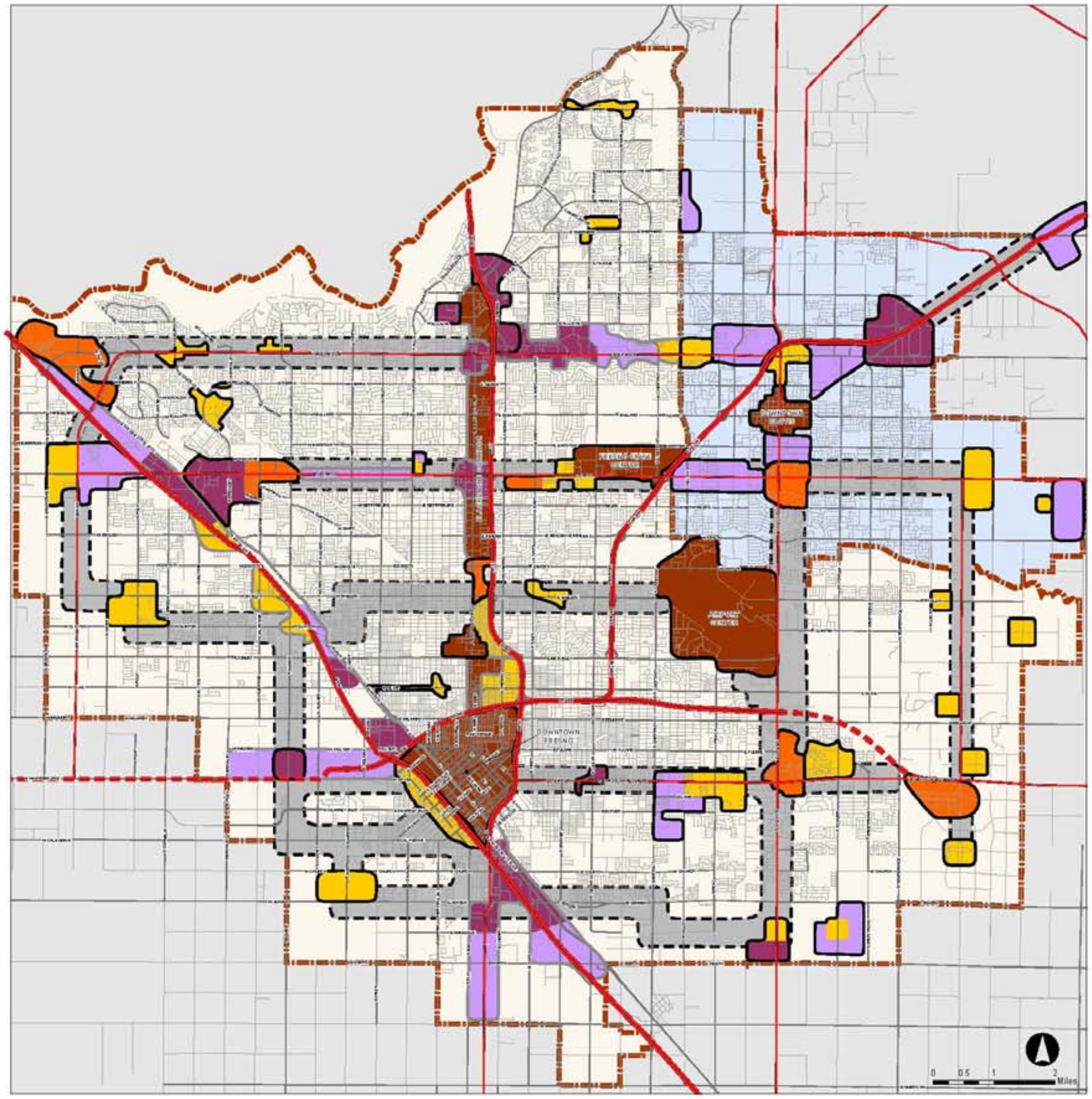


Figure 2-1
2025 General Plan Sphere of Influence



Fresno General Plan Activity Areas Evaluation and Refinement Study

The Fresno General Plan's Urban Form Element established a concept for infill and revitalization around a system of Activity Centers and Intensity Corridors. The diagram above is the starting point for moving this concept forward. Integrating Fresno's vision with one for Clovis. The effort will also integrate concepts from other efforts that are defining development opportunities within Fresno's sphere of influence, the area's transit network, and other public infrastructure investments.

The diagram indicates initial concepts for:

- **Community and Regional Centers:** mixed use areas of retail, entertainment, office, residential, and other uses that vary in terms of intensity of use and the reach of their market area.
- **District and Regional Employment Centers:** mixed use areas focusing on employment uses, some support retail and service uses, and possibly some workforce-oriented homes, again these vary in terms of intensity and the range from which they will attract employees.
- **Special Centers and Corridors:** mixed use areas with a particular focus or anchor use - downtown, Fresno State, the Airport.
- **Potential Transit Oriented Corridors:** potential land use intensification areas along potential high-occupancy transit lines, further assessment will identify Activity Areas and concepts for revitalization that can take best advantage of investment in transit.

This diagram is an initial concept, the December 9th Workshop is the start of a cooperative planning process to refine this framework vision for Fresno's future.

LEGEND

MAJOR ROADS
PROPOSED MAJOR ROADS
LOCAL ROADS
METRO RURAL LOOP SUB-LOOP & SPOKES
FREEWAYS
PROPOSED FREEWAYS
MAJOR ROADWAYS

ACTIVITY CENTER
INTENSITY CORRIDOR
POTENTIAL TRANSIT ORIENTED CORRIDOR
FRESNO CITY BOUNDARY
CLOVIS CITY BOUNDARY

FUTURE TYPOLOGIES
COMMUNITY CENTER
REGIONAL CENTER
DISTRICT EMPLOYMENT CENTER
REGIONAL EMPLOYMENT CENTER
SPECIAL CENTER/CORRIDOR

NOTE: STUDY MAY IDENTIFY OTHER MAJOR AND LIKELY MANY MINOR INTENSITY CORRIDORS.

2050 ACTIVITY CENTER & TRANSIT ORIENTED CORRIDOR TYPOLOGIES KEY MAP

City Of Fresno

November 24, 2008

COMMUNITY DESIGN + ARCHITECTURE
REGION • CITY • NEIGHBORHOOD • BUILDING

City of FRESNO

o:\c\439\02-05-01\wp\ph2\Jan2011\Chapter 2 Figs.ppt
Last Revised: 05-25-10

Figure 2-2
Proposed Activity Centers and Intensity Corridors

Figure 2-3. Available Water Supply in 2025 Under Various Hydrologic Conditions

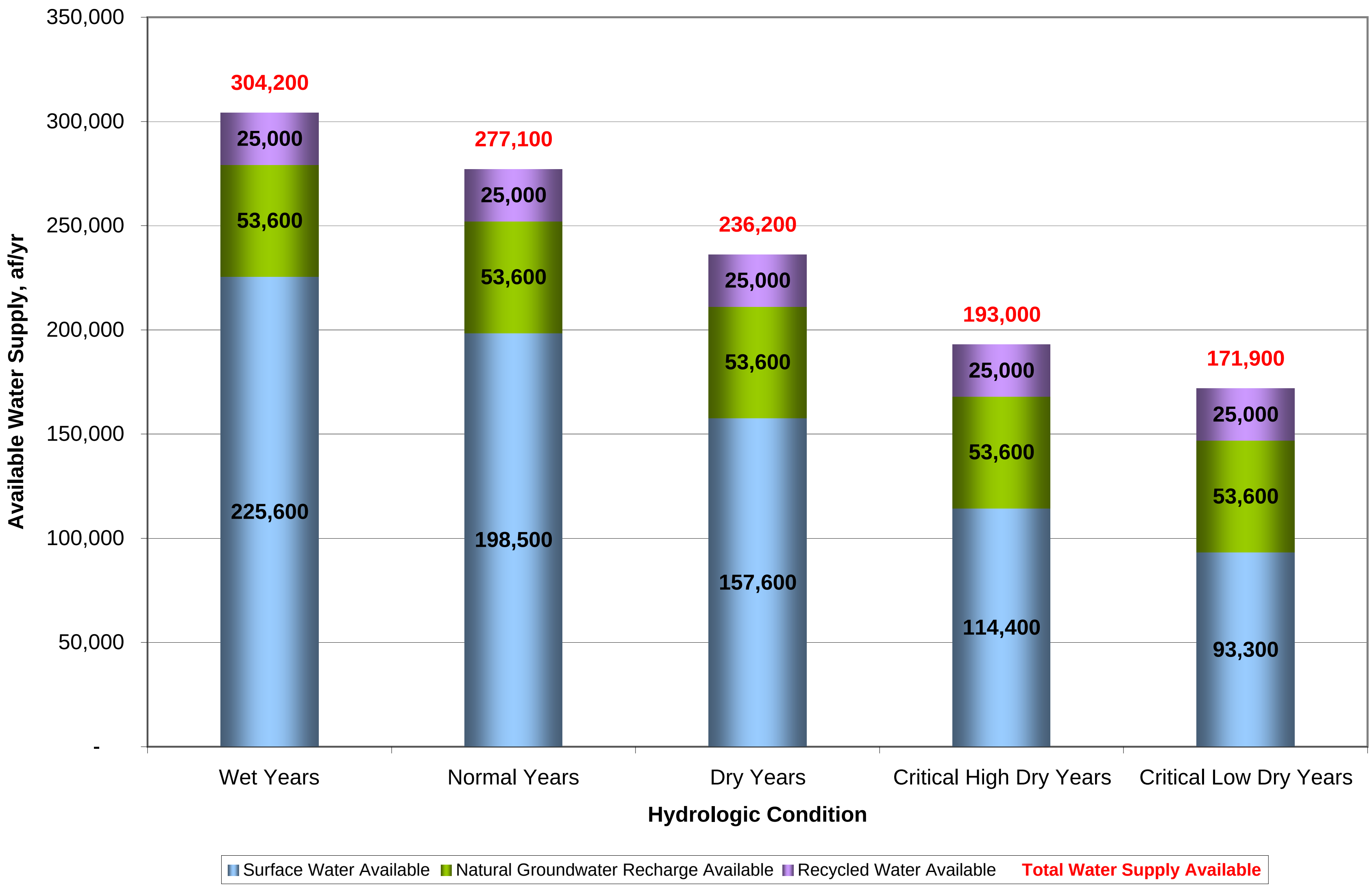
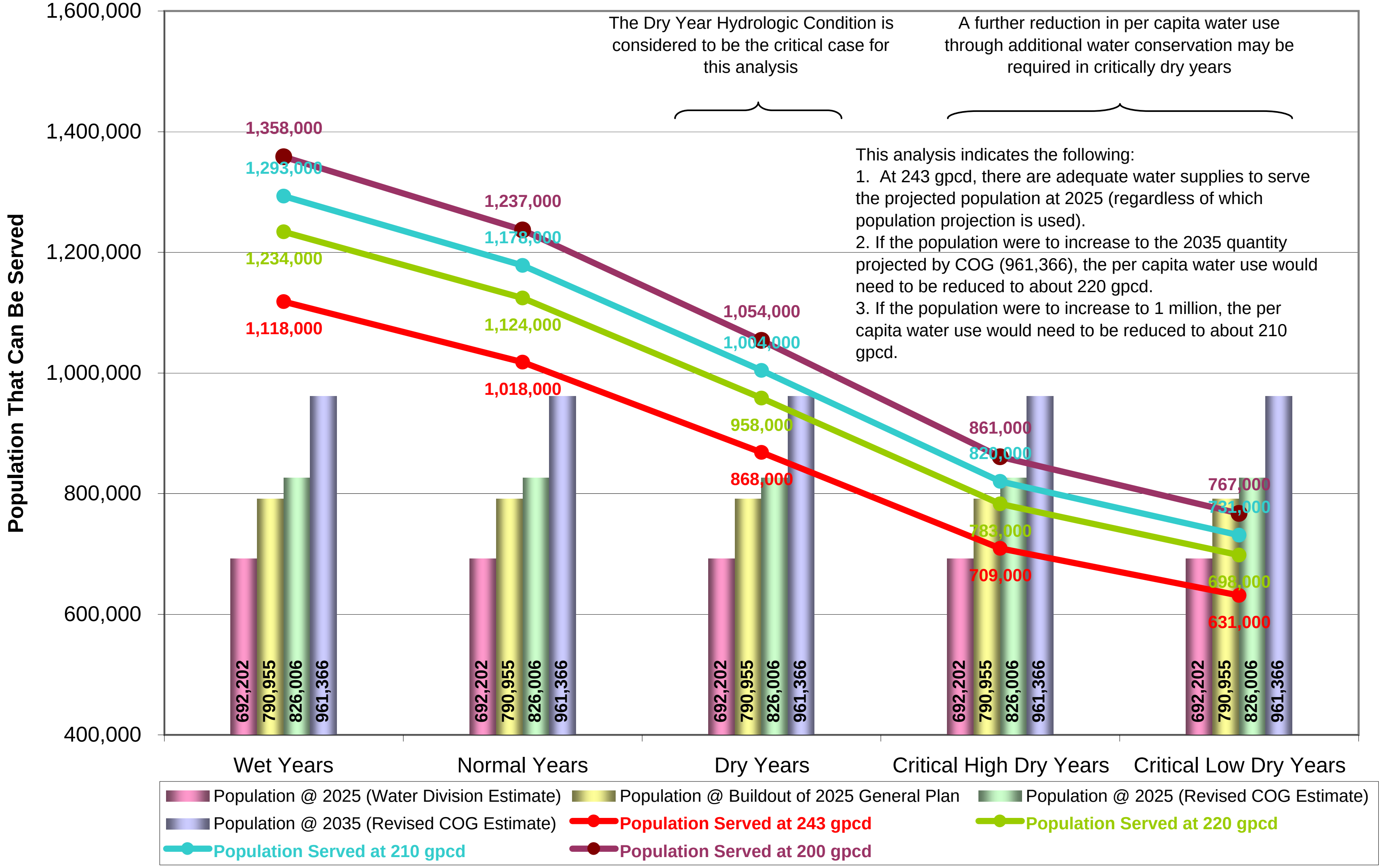


Figure 2-4. Population That Can Be Served Using Available Supplies in 2025 at Various Per Capita Water Use



CHAPTER 3. FUTURE WATER SUPPLY PLAN

This chapter presents the City's recommended future water supply plan. As described in the Phase 1 Report, the City's projected future water demands are significantly higher than previously projected in the 1996 Metro Plan, and existing available water supplies are limited. This chapter describes what has changed since the 1996 Metro Plan and the recommended future water supply plan to address the City's future needs. Subsequent chapters of this Phase 2 Report describe the specific goals, policies, and recommendations for each future water supply source.

SUMMARY OF 1996 METRO PLAN FINDINGS AND RECOMMENDATIONS

The 1996 Metro Plan recommended a water supply plan to serve the Fresno-Clovis Metropolitan Area through the year 2050. The 1996 Metro Plan, developed in the early 1990's, projected that City of Fresno water demands (with conservation) would increase to 121,000 acre-feet per year (af/yr) by the year 2000, and 248,000 af/yr by the year 2050.

Proposed future water supplies to meet these demands included the proposed use of untreated canal water for non-potable landscape irrigation, treated surface water at two new surface water treatment facilities (a northeast plant and a southeast plant), and groundwater from existing and new wells. Intentional groundwater recharge facilities and operations were proposed to be expanded to gradually restore declining groundwater levels and provide some drought contingency storage. Based on the 1996 Metro Plan, by 2010, the net recharge to the groundwater basin would be +10,000 af/yr (helping to restore groundwater levels) and by 2050 the net recharge to the groundwater basin would be 0 af/yr (indicating a long-term balanced plan where annual City groundwater pumpage equaled annual recharge).

Table 3-1 provides a summary of the future supply plan recommended in the 1996 Metro Plan.

Table 3-1. 1996 Metro Plan Supply Plan for City of Fresno[a]

Demand/Supply Component	Demand and Supply, af/yr		
	2000	2010	2050
DEMAND			
Demand (without conservation)	129,000	163,000	321,000
Conservation[b]	(8,000)	(35,000)	(73,000)
Total Demand (with conservation)	121,000	128,000	248,000
SUPPLY			
Untreated Canal Water for Landscaping	3,000	7,000	13,000
Treated Surface Water			
Northeast Surface Water Treatment Facility	10,000	10,000	25,000
Southeast Surface Water Treatment Facility	0	15,000	25,000
Total Treated Surface Water	10,000	25,000	50,000
Groundwater	108,000	96,000	185,000
Total Supply	121,000	128,000	248,000
GROUNDWATER RECHARGE			
Natural Groundwater Recharge[c]	43,000	43,000	43,000
Urban Intentional Recharge	63,000	63,000	142,000
Total Groundwater Recharge	106,000	106,000	185,000
NET GROUNDWATER RECHARGE (Recharge – Pumpage)	**-2,000**	**+10,000**	**0**

(a) Source: 1996 Metro Plan Phase III Report Table 2-1.
(b) The 1996 Metro Plan assumed about a 10 percent savings due to metering would be achieved by 2010 (assumed metering would be completed by 2010), and another 10 percent savings would be achieved due to implementation of new water conservation measures.
(c) For the 1996 Metro Plan, natural groundwater recharge was estimated to be 43,000 af/yr.

OVERVIEW OF CURRENT SUPPLY AND DEMAND CONDITIONS

2009 Demand

In 2009, the City's total water production (demand) was 157,817 af/yr. This water production was significantly higher that what was projected in the 1996 Metro Plan. The 1996 Metro Plan projected that the demand in 2009 would be about 127,300 af/yr (interpolated based on the 2000 and 2010 values shown in Table 3-1). Therefore, the 2009 actual demand was about 30,500 af/yr higher, or about 24 percent higher, than what was previously projected. This higher demand is due to the large amount of growth which has occurred since the late 1990s, and less actual water conservation than what was anticipated (i.e., the 1996 Metro Plan assumed that there would be a significant savings due to the installation of meters by 2010 and implementation of other new water conservation measures).

2009 Supplies

To meet these larger than previously anticipated demands, in 2009 the City used its Northeast Surface Water Treatment Facility (SWTF) (completed in late 2004) and pumped more local groundwater. Approximately 12 percent of the demands were met using treated surface water (19,563 af/yr) from the Northeast SWTF. The majority of demands (about 88 percent) were met using groundwater pumped from the City's wells (about 138,254 af/yr).

2009 Groundwater Recharge

As described in the Phase 1 Report, intentional groundwater recharge occurs at numerous facilities throughout the City service area. In 2009, intentional recharge was 54,617 af. Therefore, based on the City's groundwater pumpage, estimates of natural recharge, and intentional recharge, the net groundwater recharge was -30,037 af/yr (e.g., groundwater pumpage exceeded total groundwater recharge by 30,037 af/yr) (see Table 3-2). Another way to view this is that 30,037 af was pumped from groundwater storage.

In the future, for the City to achieve and maintain balanced groundwater operations (whereby groundwater recharge equals or exceeds groundwater pumpage), the City will need to at least maintain its existing intentional recharge quantities. Ideally, the City will continue to increase its intentional recharge capacity through the increased use of existing recharge facilities and construction and maintenance of new recharge facilities to allow for increased recharge in years when surplus surface water is available. This will be an important component of the City's future water supply plan as described further below.

Table 3-2 summarizes the City's 2009 supply and demands.

Table 3-2. City of Fresno 2009 Supply and Demand

Demand/Supply Component	2009 Supply and Demand, af/yr
DEMAND	
Demand (without conservation)	--
Conservation	--
2009 Total Demand (with existing conservation)	157,817
SUPPLY	
Untreated Canal Water for Landscaping	--
Treated Surface Water	
Northeast Surface Water Treatment Facility	19,563[a]
Southeast Surface Water Treatment Facility	0
Total Treated Surface Water	19,563
Groundwater	138,254
2009 Total Supply	157,817
GROUNDWATER RECHARGE & SUBSURFACE INFLOW	
Deep Percolation from Rain and Applied Water[b]	17,000
Seepage from Major Canals[b]	15,500
Net Subsurface Boundary Inflow[b,c]	21,100
Urban Intentional Recharge[d]	54,617
2009 Total Groundwater Recharge & Subsurface Inflow	108,217
NET GROUNDWATER RECHARGE (Total Recharge of 108,217 af – Pumpage of 138,254 af)	**-30,037**

(a) Based on 2009 SWTF deliveries.
(b) Based on City of Fresno estimated proportionate share of long-term average deep percolation, seepage and subsurface inflow within the Fresno SOI as estimated by WRIME in focused groundwater modeling performed for Phase 2 of the Metro Plan Update in December 2008 (see additional discussion in Chapter 5 and in Appendix D of this Phase 2 Report).
(c) Includes San Joaquin River seepage.
(d) Actual intentional recharge for 2009.

SUMMARY OF PROJECTED FUTURE WATER DEMANDS AND AVAILABLE SUPPLIES

Projected Future Water Demands

Chapter 2 describes the City's revised projected future demands based on buildout of the City's 2025 General Plan. As described in Chapter 2, the projected demand incorporates a 10 percent reduction in residential demand as a result of the City's implementation of the residential metering program (which must be completed by March 2013). By 2025, the projected water demand is estimated to be 260,400 af/yr. With an assumed 10 percent of additional water conservation in the future, the projected water demand in 2025 is 234,400 af/yr. This is about 56,300 af, or approximately 35 percent higher than the 2025 demand projected in the 1996 Metro Plan. Table 3-3 summarizes the projected future water demand. These projected demands, in comparison to the previous 1996 Metro Plan projections, are shown on Figure 3-1.

Table 3-3. Projected City of Fresno Future Demands

	2010	2015	2020	2025
1996 Metro Plan				
Projected Demand with Conservation, af/yr	128,000	143,000	158,000	173,000
Metro Plan Update				
Projected Demand with Metering Only, af/yr[a]	171,900	199,300	229,300	260,400[b]
Projected Demand with 10% Additional Water Conservation, af/yr	163,300	189,300	206,400	234,400[b]
Percent Increase from 1996 Metro Plan Estimate	+28%	+32%	+31%	+35%

(a) Includes 10 percent conservation for residential customers due to metering program, but does not include additional conservation.
(b) Based on a revised water demand projection for the SEGA project area. See discussion in Chapter 2.

Future Available Water Supplies

As described above, the City currently uses treated surface water and local groundwater to meet demands. The groundwater supply is composed of a combination of natural recharge, intentional recharge, subsurface inflow, and groundwater in storage. The available surface water supply is based on the total available surface water supply (per existing agreements) based on hydrologic conditions and consists of supplies from FID, USBR, and the FID Wastewater Recycled Water Exchange. For this analysis, it is assumed that all available surface water supplies will be used, either for treatment and direct use, or intentional groundwater recharge.

Figure 3-2 graphically presents the City's future supply and demand using currently available supplies under normal year supply conditions. As shown in Figure 3-2, if only the existing available supplies are used, supply shortfalls occur in 2025 if the only water conservation assumed is that associated with the residential water meter program. Under this assumption, in 2025 (corresponding with buildout of the City's 2025 General Plan), the supply shortfall would be approximately 8,300 af/yr. If 10 percent additional water conservation is assumed, the projected supply shortfall in 2025 in normal years is eliminated. However, it should be noted that these projected shortfalls are based on normal year supply conditions, and would be much greater and occur sooner under dry year conditions.

FUTURE WATER SUPPLY PLAN OBJECTIVES AND GOALS

As part of the City's future water supply program, the City has proposed a number of overall and specific objectives and goals. The overall objective and goals of the City's future water supply plan are listed in Table 3-4.

Table 3-4. Overall Objective and Goals of City's Future Water Supply Plan

OVERALL OBJECTIVE	To provide sustainable and reliable water supplies to meet the demands of existing and future customers through buildout of the General Plan (2025)
Goal #1	Maximize use of available surface water supplies for direct treatment and use, and intentional groundwater recharge
Goal #2	Balance the City's groundwater use by 2025 (City's annual groundwater extraction = City's annual intentional recharge; 2025 corresponds to buildout of General Plan)
Goal #3	Replenish groundwater basin storage when surplus surface water supplies are available
Goal #4	Continue to implement and expand demand management/water conservation measures in compliance with the City's USBR contract and to achieve specific water conservation goals
Goal #5	Incorporate tertiary-treated recycled water into the City's future water supply portfolio, to meet non-potable demands in new development areas and existing parts of the City to offset potable water demands

In addition, to provide the required staffing and support for the future water supply plan, the City must re-evaluate its Water Division organizational structure, roles, responsibilities, and staffing needs.

Specific objectives, goals, and policies related to individual components of the plan are discussed below and in the subsequent chapters of this Phase 2 Report.

FUTURE SUPPLY COMPONENTS

To meet the City's overall objectives and goals, the recommended future water supply plan for the City includes several key components to meet the stated goals of the plan. These are summarized in Table 3-5.

Table 3-5. Key Components of the City's Future Water Supply Plan

Future Water Supply Plan Component	Goal #1: Maximize Use of Surface Water	Goal #2: Balance Groundwater Use by 2025	Goal #3: Replenish Groundwater Basin Storage	Goal #4: Continue and Expand Water Conservation	Goal #5: Incorporate Recycled Water
Water Conservation: Implementation of expanded and additional water conservation measures		✓	✓	✓	
Groundwater: Balanced use of local groundwater resources such that ultimately, the City's annual groundwater pumpage would essentially be equivalent to the City's annual recharge and implementation of a groundwater banking program	✓	✓	✓		
Surface Water: Maximized use of available surface water either through treatment and direct use and/or intentional groundwater recharge	✓	✓	✓		
Recycled Water: Use of recycled water to meet landscape irrigation or other non-potable demands in new development areas, and existing landscaped areas throughout the City to offset potable water demands		✓	✓		✓
Future New Water Supply: Acquisition of future new water supplies to increase the diversity and reliability of the City's water supply portfolio		✓	✓		

Table 3-6 provides a summary of the specific objectives for each of these future water supply plan components. The specific goals and policies established for each of the City's future water supply plan components are described in the subsequent chapters of this Metro Plan Update Phase 2 Report.

Table 3-6. Specific Objectives for the City's Future Water Supply Plan

Future Water Supply Plan Component	Specific Future Water Supply Plan Objectives
Water Conservation (see Chapter 4)	• Make water conservation a part of everyday life for all residents and businesses in Fresno, not just something that is mandated only in dry years. • Continue to implement and expand demand management/water conservation measures in compliance with the City's USBR contract and to achieve specific water conservation goals. • Reduce existing and future demands through more aggressive water conservation measures, leading to a lowering of the per capita daily water use.
Groundwater (see Chapter 5)	• Balance the City's annual groundwater pumpage with annual intentional recharge to minimize further groundwater level declines and potential water quality degradation. • Maintain adequate groundwater pumping capacity and system redundancy and reliability to meet demands during dry periods and emergencies when surface water supplies may be reduced. • Implementation of a local groundwater banking program to allow for banking of surplus water supplies available in wet years for later extraction in dry years.
Surface Water (see Chapter 6)	• Increase conjunctive use of available supplies. • Increase use of available surface water supplies for treatment and direct use. • Use of any additional available surface water supplies for intentional groundwater recharge and/or groundwater banking to help achieve groundwater basin stabilization and replenishment.
Recycled Water (see Chapter 7)	• Increase the use of recycled water for landscape irrigation and other non-potable uses to help offset existing and future potable water demands. • Maximize the use of available recycled water exchange supply from the 1976 FID agreement.
Future New Supply (see Chapter 8)	• Consider water conservation as an additional water supply source, by reducing projected future demands and the need for future new water supplies. • Evaluate and, if appropriate, pursue and acquire new surface water and/or other water supply sources to increase the diversity and reliability of the City's water supply portfolio. • Implement a local groundwater banking program.

The proposed use of these supply components to meet the City's projected future demands during normal year hydrologic conditions is shown on Figure 3-3 and is described below.

Water Conservation

The recommended future water supply plan includes an additional water conservation component to reduce projected future demands. The City has had an extensive water conservation program in place for many years; however, the City's overall per capita water use is still quite high. The City's average overall per capita water use over the last 20 years (1990 to 2009) has been about 300 gallons per capita per day (gpcd). In 2007 and 2008, the per capita water use was about 300 gpcd, consistent with the long-term average per capita water use. However, in 2009, the City's average overall per capita water use dropped to 275 gpcd as a result of stepped up water conservation efforts in response to the third year of the drought.

The programs described below are intended to make water conservation a part of everyday life for all residents and businesses in Fresno, not just something that is mandated only in dry years.

<u>Residential Water Metering Program</u>

The City has begun the implementation of a residential water metering program which will provide for the installation of water meters on all residential connections by March 2013 and has implemented a metered water rate structure for all of its metered customers. This metering program is expected to reduce residential water demand by about 10 percent due to increased water use awareness by residential customers. It is assumed that this 10 percent reduction will occur incrementally beginning in 2010 and will be fully achieved by March 2013 with the completion of the residential metering program. Based on these assumed reductions, but not including any additional conservation, the overall per capita water use would be reduced to about 270 gpcd by 2013. Also, by having all of its customers metered, the City will be better able to measure the success of its overall water conservation program and improve its management of available water resources. As meter installations are completed customers will be converted from the current flat-rate water rate structure to a quantity-based water rate structure. In the future, the City may develop a tiered water rate structure to further encourage water conservation.

<u>Additional Water Conservation Measures</u>

Additional water conservation will be a critical part of the City's future water supply plan. To further decrease the overall per capita water use, additional water conservation measures are recommended as part of the City's future water supply plan. An additional 5 percent overall conservation by all customers is recommended starting in 2010 (to reduce the per capita water use to 257 gpcd once all of the reductions due to residential metering are achieved), and an additional 5 percent (10 percent total) by all customers is recommended starting in 2020 (to reduce the per capita water use to 243 gpcd).

Proposed water conservation measures are described in Chapter 4. As discussed in Chapter 4, the biggest opportunities for water conservation are related to the reduction of outdoor water uses, particularly landscape and turf irrigation, by all customers. Several potential measures related to outdoor water use reduction are discussed in Chapter 4 and include the following:

- Xeriscape Landscape Rebate for New Homes;
- Programmable Irrigation Controller Rebate;

- Weather-Based Irrigation Controller Rebate;
- Turf Replacement Rebate ("Cash for Grass"); and
- Landscape Water Audit and Budget Program.

The conservation measures described in this report, particularly those related to reduction of outdoor water uses, should be implemented as soon as possible. It is anticipated that the implementation of these new water conservation measures, along with the continuation of the City existing water conservation programs, will be further enhanced with the completion of the residential metering program, implementation of metered water rates (and eventually tiered water rates) and customers' increased awareness of the need to conserve water in California.

Reduction in Per Capita Water Use

Table 3-7 shows the projected reduction in per capita water use as a result of assumptions described above.

Table 3-7. Projected Reduction in Per Capita Water Use

	Projected Per Capita Water Use, gpcd			
	2010	2015	2020	2025
Long-Term Average Per Capita Water Use (1990-2009) (without residential water metering or additional conservation), gpcd	300	300	300	300
Projected Per Capita Water Use as a result of residential water metering (10 percent reduction by March 2013), gpcd	293	270	270	270
Projected Per Capita Water Use as a result of 5 percent conservation by all customers starting in 2010, gpcd	278	257	257	257
Projected Per Capita Water Use as a result of 5 percent additional conservation by all customers starting in 2020, gpcd	--	--	243	243
Resulting Per Capita Water Use, gpcd	278	257	243	243

These per capita water use goals are considered to be achievable based on the City's current per capita water use, and are consistent with per capita water use in neighboring communities (e.g., City of Clovis, whose 2005 per capita water use was 248 gpcd). As described in Chapter 2, these goals are also consistent with the recently passed SB X7-7 legislation calling for a statewide 20 percent reduction in per capita water use.

A more detailed discussion of this additional water conservation, along with recommended new conservation policies, is provided in Chapter 4 of this Phase 2 Report.

Groundwater

As shown on Figure 3-3, in the coming years before expansion of the City's surface water treatment capacity, groundwater will continue to be the City's primary water supply source. In the years between now and 2025, a maximum groundwater pumpage of 152,450 af/yr occurs in 2014, the year before completion of the proposed new Southeast SWTF. This maximum groundwater pumpage is no greater than historical groundwater pumpage by the City, and is therefore, assumed to be feasible, assuming additional groundwater recharge facilities are also constructed (see below). However, following completion of the new Southeast SWTF in 2015, groundwater pumpage decreases to 85,500 af/yr. The City's projected groundwater pumpage drops even further with the expansion of the City's Northeast SWTF in 2020 and the introduction of recycled water supplies for potable water demand offset in 2025.

In 2009, the City's intentional recharge was 54,617 af. This intentional recharge was higher than in previous years, due to a significant increase in recharge at the FMFCD basins and a moderate increase at the City's Leaky Acres facility. However, recharge at the City's Leaky Acres facilities was still only 9,517 af, which is significantly lower than historical recharge at that facility. This was due to maintenance operations and a reduced delivery season.

With the City's on-going maintenance of existing recharge facilities and the acquisition of additional properties for new recharge facilities within the City's SOI, it is assumed that the current 2009 intentional recharge quantity of about 54,600 af/yr can be maintained in the future. As shown in Table 3-8, assuming that the City's groundwater pumpage can be reduced as a result of the proposed additional surface water treatment capacity, the City's existing intentional recharge of 54,600 af/yr is adequate to achieve and maintain a balance of the City's groundwater operations beginning as early as 2015. As shown in Figure 3-3, from 2015 through 2025, the maximum projected groundwater pumpage is 108,300 af (in 2019). As shown in Table 3-8, if the intentional recharge is 54,600 af/yr, the total estimated recharge (natural plus intentional) is estimated to be 108,200 af/yr, indicating that the current intentional recharge quantity of 54,600 af/yr is adequate to achieve and maintain balanced groundwater operations beginning in 2015 and continuing through at least 2025. However, if the additional surface water treatment capacity is not available, or is delayed for any reason, the required groundwater pumpage will increase and additional intentional recharge will be required to achieve and maintain balanced groundwater operations.

As described further in Chapter 5, ideally the City will continue to increase its recharge capacity through the increased use of existing recharge facilities and construction and maintenance of new recharge facilities to allow for increased recharge in years when surplus surface water is available.

Table 3-8. Required Intentional Recharge to Achieve and Maintain Balanced Groundwater Operations

	2010	2015	2020	2025
Estimated Natural Recharge				
Deep Percolation from Rain and Applied Water, af/yr[(a)]	17,000	17,000	17,000	17,000
Seepage from Major Canals, af/yr[(a)]	15,500	15,500	15,500	15,500
Net Subsurface Inflow, af/yr[(a)]	21,100	21,100	21,100	21,100
Intentional Recharge (based on 2009 recharge quantity), af/yr	54,600	54,600	54,600	54,600
Total Groundwater Recharge, af/yr	108,200	108,200	108,200	108,200
Projected Future Groundwater Pumpage, af/yr (see Figure 3-3)	131,750	85,500	82,000	86,000
Total Additional Intentional City Recharge Required to Balance Groundwater Operations, af/yr = Projected Pumpage – Total Current Recharge[(b)]	23,550	Balanced[(c)]	Balanced[(c)]	Balanced[(c)]
Groundwater Returned to Storage ("Banked")	0	22,700	26,200	22,200
Minimum Intentional Recharge to Maintain Balanced Groundwater Operations, af/yr[(d)]	78,150	31,900	28,400	32,400

(a) Based on City of Fresno estimated proportionate share of long-term average deep percolation, seepage and subsurface inflow within the Fresno SOI as estimated by WRIME in focused groundwater modeling performed for Phase 2 of the Metro Plan Update in December 2008 (see additional discussion in Chapter 5 and in Appendix D of this Phase 2 Report).

(b) In 2015, 2020 and 2025, the amount of intentional recharge required for balance is less than the current recharge quantity of 54,600 af/yr. This is because groundwater pumpage quantities are reduced in these years as a result of the availability of additional treated surface water supplies from the expanded Northeast SWTF and new Southeast SWTF. If these additional treated water supplies are not available, or are delayed, additional intentional recharge will be required to achieve and maintain balanced groundwater operations.

(c) City pumpage is less than projected recharge quantity; surplus groundwater recharge achieved. See Groundwater Returned to Storage ("Banked").

(d) This is the minimum amount of intentional recharge required to achieve and maintain balanced groundwater operations. Calculated based on projected groundwater pumpage minus estimated natural recharge (deep percolation plus seepage plus net subsurface inflow).

As described in Chapter 5, improvements to the City's intentional groundwater recharge operations may be achieved through the construction of new recharge basins and/or the construction of an Aquifer Storage and Recovery (ASR) Well System. A more detailed discussion of the City's future use of groundwater and groundwater recharge operations, along with recommended groundwater policies, is provided in Chapter 5 of this Phase 2 Report.

Surface Water

Figure 3-3 shows the amount of surface water proposed to be treated at City surface water treatment facilities in the future. As shown, surface water treatment capacity is proposed to increase from the current capacity of approximately 27.5 mgd (28,300 af/yr) to an average total capacity of 120 mgd (123,400 af/yr) by 2020. This increase in nominal surface water treatment capacity is proposed to occur as follows:

- Existing Northeast SWTF:
  - Currently 27.5 mgd (28,300 af/yr)
  - Increase to 30 mgd (30,800 af/yr)
  - Expanded to 60 mgd (design capacity) (50 mgd average capacity for 11 months of the year) by 2020 (51,400 af/yr)
- New Southeast SWTF:
  - 80 mgd (design capacity) (70 mgd average capacity for 11 months of the year) by 2015 (72,000 af/yr)

This increase in surface water treatment capacity is critical to the City's ability to meet the objective of balanced groundwater operations by 2025 by reducing groundwater pumpage to stop groundwater level declines and beginning to restore groundwater levels to historical levels. In addition, as described in Chapter 6, in the future the City may also wish to consider the construction of a new surface water treatment facility in the southwest portion of the City.

To maximize the use of available surface water supplies, available surface water supplies not treated for direct use are proposed to be used for intentional groundwater recharge to help balance groundwater operations. Any additional available surface water should be used for intentional recharge to the extent that intentional groundwater recharge facilities are available, and/or for groundwater banking.

As described in Chapter 6, the projected availability of surface water supplies in critically dry years may be below the proposed surface water treatment facility capacity. This means that in critically dry years it may not be possible to operate the proposed surface water treatment facilities at their full production capacities. However, in all other wetter hydrologic conditions, there are adequate surface water supplies to keep the proposed surface water treatment facilities operating at essentially full capacity.

A more detailed discussion of the City's future use of treated surface water, along with recommended surface water policies, is provided in Chapter 6 of this Phase 2 Report.

Recycled Water

Figure 3-3 shows the introduction of recycled water as a new source of supply to meet non-potable demands starting in 2010, but eventually ramping up to a supply of up to 25,000 af/yr by the year 2025 to directly offset potable water demands. It is assumed that recycled water will be used in the Southeast Growth Area, and other portions of the City, for landscape irrigation and other non-potable purposes, reducing the potable water demands. The proposed use of recycled water in 2025 and beyond is assumed to be about 25,000 af/yr[1], about 11 percent of the City's projected demand in 2025. This includes up to about 1,000 af/yr of recycled water produced at the City's new North Fresno Wastewater Reclamation Facility (WRF) and used to irrigate the Copper River Ranch Golf Course[2].

A Recycled Water Distribution Master Plan is being prepared in parallel with this Metro Plan Update to identify potential future recycled water use areas within the Southeast Growth Area, other future growth areas, and areas within the City, as well as plan for the recycled water infrastructure required to serve these areas.

A more detailed discussion of the City's future use of recycled water is provided in Chapter 7 of this Phase 2 Report.

Future New Water Supply

With the assumed completion of the residential water metering program by March 2013 and the implementation of additional water conservation measures, the City has adequate available water supplies to meet the water demands anticipated with buildout of the City's 2025 General Plan. Furthermore, as discussed in Chapter 2, these existing water supplies may be capable of meeting the demands of additional future development within the City if per capita water uses within the City can be further reduced (beyond the reductions assumed in this Metro Plan Update).

Nonetheless, the pursuit and acquisition of new water supply sources is a critical component of the City's future water supply plan, as the regulatory environment and the potential impacts of future climate change are uncertain. The City should consider pursuing additional new water supplies to increase the diversity and reliability of the City's water supply portfolio. Although the need for and timing of such new water supplies is uncertain and can only be determined in the future based on future General Plan updates, actual water demand trends and per capita water use within the City, the acquisition of new water supplies can be a lengthy process requiring numerous technical studies and feasibility evaluations, extensive negotiations and detailed environmental analysis. As such, as opportunities for new water supplies arise, the City should actively evaluate them and, if appropriate, pursue them.

Possible new water supplies may include one or more of the following:

- Additional surface water supply from FID (through re-negotiation of existing FID agreements and/or a new agreement),
- New surface water supply from Temperance Flat Dam,

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[1] The quantity of recycled water of 25,000 af/yr to be used by 2025 is based on WYA's discussions with City staff in January 2008 during conceptual development of the future water supply plan. A detailed Recycled Water Master is being prepared to identify specific recycled water use areas and quantify potential future recycled water use.

[2] As described in Chapter 7 of this Phase 2 Report, the buildout capacity of the North Fresno WRF is reported to be 1,250 af/yr. A total capacity of 1,000 af/yr by 2015 is being assumed in this Phase 2 Report to be conservative.

- Groundwater banking program,
- Water supply purchases on the open market, and/or
- Additional recycled water.

As an alternative, or in addition to these new water supplies, additional more aggressive water conservation measures could also be developed and implemented. Additional water conservation, beyond that already assumed, would reduce projected future water demands and reduce the need for new future water supplies.

The new water supply source(s) will need to be identified and pursued soon so that all required studies, negotiations/agreements, and environmental reviews can be completed in time for the supply to be available when needed.

A more detailed discussion of the City's need for future new supplies, along with recommended new water supply policies, is provided in Chapter 8 of this Phase 2 Report.

Figure 3-1. Comparison of Future City of Fresno Water Demand Projections

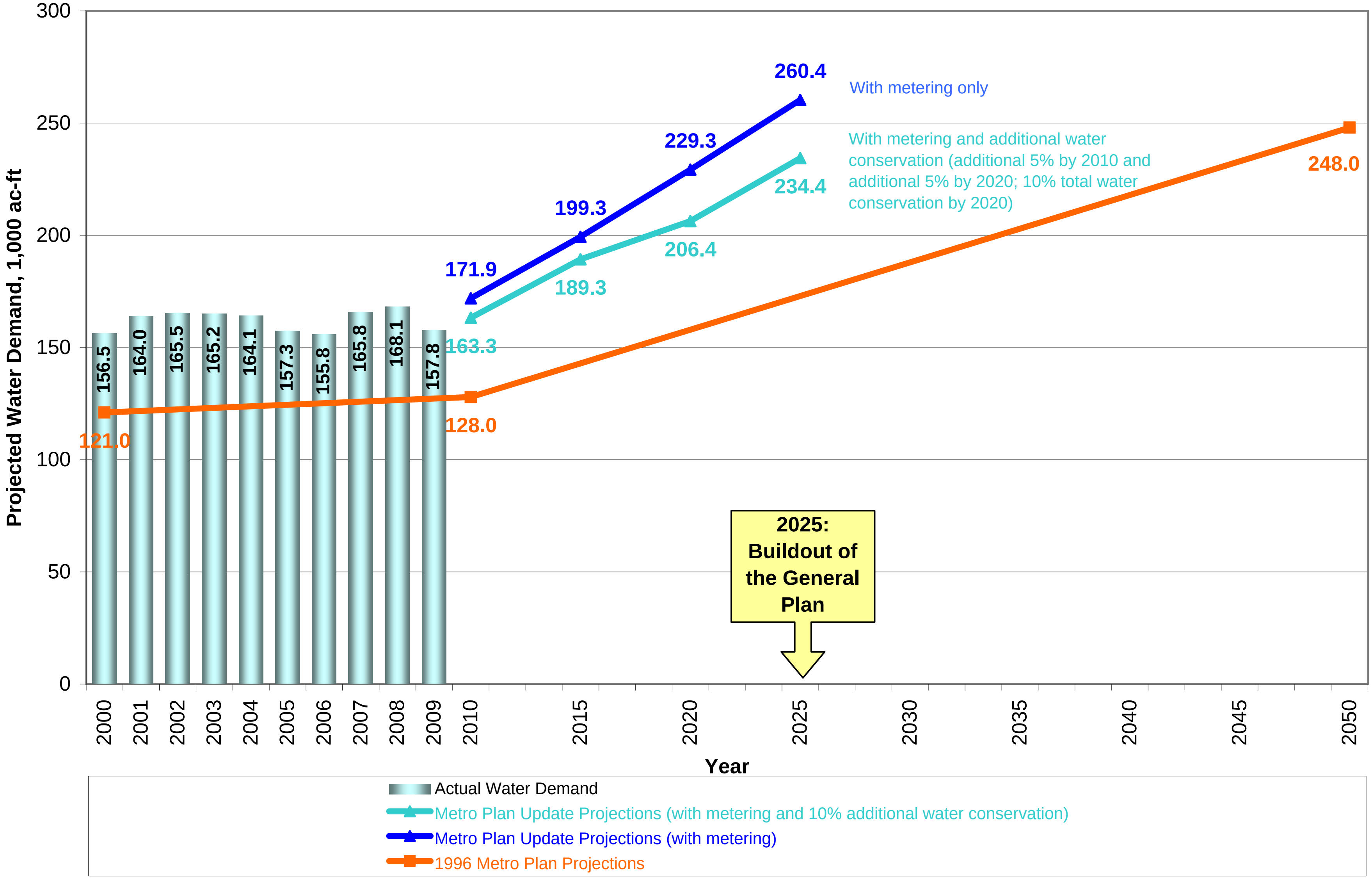


Figure 3-2. City of Fresno Future Supply and Demand Using Only Existing Available Supplies (Normal Years)

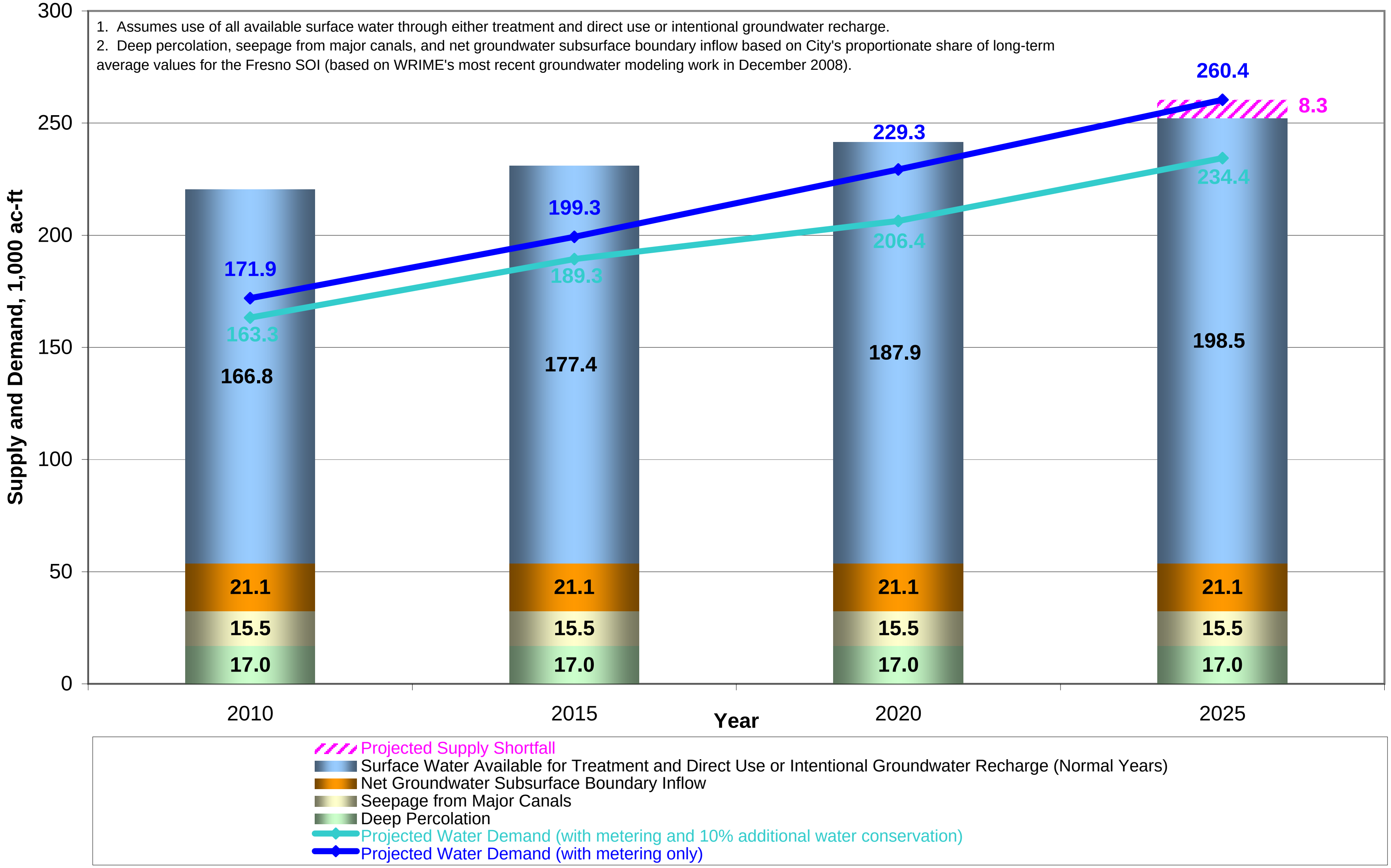
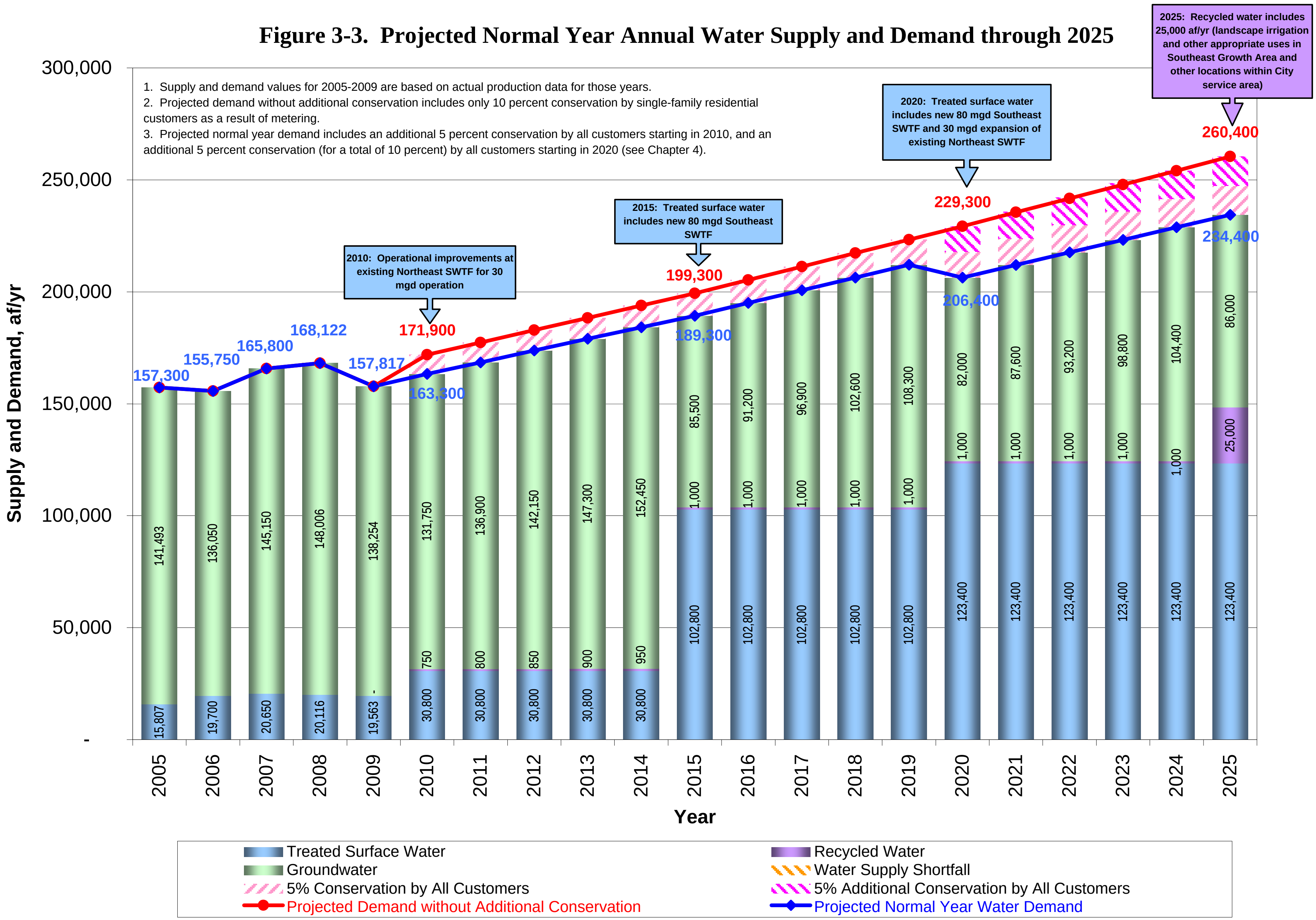


Figure 3-3. Projected Normal Year Annual Water Supply and Demand through 2025



CHAPTER 4. FUTURE ADDITIONAL WATER CONSERVATION MEASURES

This chapter presents a description of potential additional water conservation measures which the City may consider implementing in the future as part of its overall future water supply plan. These future water conservation measures are in addition to the City's current water conservation program, described previously in Chapter 4 of the Phase 1 Report and Chapter 8 of the City's Urban Water Management Plan (UWMP).

FUTURE WATER CONSERVATION PROGRAM OBJECTIVE, GOALS, AND POLICIES

As described in Chapter 3, as part of the City's future water supply program, the City has proposed a number of specific objectives, goals, and policies. The specific objectives, goals, and policies related to water conservation include the following:

Water Conservation Objectives

- Make water conservation a part of everyday life for all residents and businesses in Fresno, not just something that is mandated only in dry years;
- Continue to implement and expand demand management/water conservation measures in compliance with the City's USBR contract and to achieve specific water conservation goals; and
- Reduce existing and future demands through more aggressive water conservation measures.

Water Conservation Goals

- Complete the residential water metering program as soon as possible (no later than March 2013)
- Reduce overall per capita water use to 243 gallons per capita per day (gpcd) by 2020 as follows:
  - Reduce residential water use by 10 percent by March 2013 (as a result of the residential water metering program)
  - Further reduce overall per capita water use through implementation of expanded and additional water conservation measures:
    - By 2010, reduce overall water use by all customers by an additional 5 percent (to 278 gpcd)
    - By 2020, reduce overall water use by all customers by an additional 5 percent (total 10 percent) (to 243 gpcd)

It should be noted that these water conservation goals are consistent with the SB X7-7 legislation passed in October 2009 which calls for a 20 percent reduction in per capita water use statewide by the year 2020 (also known as "20 x 2020").

Water Conservation Policies

- Implement a tiered water rate structure as soon as possible to further encourage water conservation;
- Require new development to offset a portion their required supply needs by implementing conservation measures;
- Establish aggressive water conservation goals/policies for new construction;
- Establish more efficient exterior water use goals/policies for existing users including water conservation measures specifically geared towards reducing water use for landscape and turf irrigation;
- Provide additional Water Division staff, and program-specific financial resources required to implement and manage the water conservation programs;
- Maintain compliance with the CVP Contract, including the BMP requirements; and
- Update the City's UWMP every five years per State requirements.

CURRENT AND PLANNED WATER CONSERVATION MEASURES

The City has had an extensive water conservation program in place for many years; however, the City's overall per capita water use is still quite high compared to other similar communities. The City's average overall per capita water use over the last 20 years has been about 300 gpcd. In both 2007 and 2008, overall average per capita water use was about 300 gpcd, consistent with the long-term average. However, in 2009, the overall average per capita water use dropped to about 275 gpcd. This was likely a direct result of the City's enhanced water conservation efforts during the third year of a statewide drought.

The programs outlined below are intended to make water conservation activities and awareness a part of everyday life for all residents and businesses in Fresno, not just something that is mandated only in dry years. These programs and measures are intended to change attitudes and habits with regard to water use in the City, and as discussed in Chapter 2 are consistent with statewide goals to reduce per capita water use throughout California.

Residential Water Metering Program

The City has begun the implementation of a residential water metering program which will provide for the installation of water meters on all residential connections by March 2013 and has implemented a quantity-based water rate structure for all of its metered customers. This metering program is expected to reduce residential water demand by about 10 percent due to increased water use awareness by residential customers. It is assumed that this 10 percent reduction will occur incrementally beginning in 2010, and will be fully achieved by March 2013 with the completion of the residential metering program. Based on these assumed reductions, but not including any additional conservation, the overall per capita water use would be reduced to about 270 gpcd by 2013 (see Figure 4-1). Also, by having all of its customers metered, the City will be better able to measure the success of its overall water conservation program and improve its management of available water resources.

Additional Water Conservation

As described in Chapter 3, additional water conservation will be an important part of the City's future water supply plan. To further decrease the overall per capita water use, additional water conservation measures are recommended as part of the City's future water supply plan. An additional 5 percent overall conservation by all customers is recommended starting in 2010 (to reduce the per capita water use to 257 gpcd once all of the reductions due to residential metering are achieved), and an additional 5 percent (10 percent total) by all customers is recommended starting in 2020 (to reduce the per capita water use to 243 gpcd). As shown on Figure 4-1, these recommended water conservation reductions would reduce the projected per capita water use even more than just with the residential water metering program. Table 4-1 shows the anticipated reductions in overall per capita water use and the resulting reduction in projected future water demand.

Table 4-1. Reduction in Projected Future Demand as a Result of Additional Water Conservation

	2010	2015	2020	2025
Long-Term Average Per Capita Water Use (1990-2009) (without residential water metering or additional conservation), gpcd	300	300	300	300
Projected Per Capita Water Use as a result of residential water metering (10 percent reduction by March 2013), gpcd	293	270	270	270
Projected Per Capita Water Use as a result of 5 percent conservation by all customers starting in 2010, gpcd	278	257	257	257
Projected Per Capita Water Use as a result of 5 percent additional conservation by all customers starting in 2020, gpcd	--	--	243	243
Resulting Per Capita Water Use, gpcd	278	257	243	243
Projected Demand, af/yr[(a)]	171,900	199,300	229,300	260,400
5% Additional Conservation by All Customers starting in 2010, af/yr	(8,600)	(10,000)	(11,500)	(13,000)
5% Additional Conservation by All Customers starting in 2020, af/yr			(11,500)	(13,000)
Projected Demand with Additional Conservation, af/yr	163,300	189,300	206,400	234,400

(a) Includes 10 percent conservation for residential customers due to metering program, but does not include additional conservation.

These per capita water use goals are considered to be achievable based on the City's current per capita water use, and are consistent with per capita water use in neighboring communities (e.g., City of Clovis whose 2005 per capita water use was 248 gpcd). As stated above, these goals are also consistent with the requirements of the recently passed SB X7-7 legislation which calls for a statewide 20 percent reduction in per capita water use.

POTENTIAL FUTURE WATER CONSERVATION MEASURES

As part of its efforts to increase water conservation within the City, the City Water Division is considering several other potential future water conservation measures. These potential future measures are summarized in Table 4-2 and described below. For each potential program, a description of the City's planned implementation is provided along with a proposed schedule.

Table 4-2. Potential Future Water Conservation Measures

Measure Description	Proposed Implementation[(a)]
Residential Water Metering Program (see discussion above under Current and Planned Water Conservation Measures)	To start in 2010 and be complete by March 2013
Billing with Commodity Rates (see discussion above under Current and Planned Water Conservation Measures)	Started in 2010
Implementation of Tiered (Increasing Block) Water Rate Structure	As soon as possible following completion of Residential Water Metering Program to further encourage water conservation
Prioritized Leak Detection Program	2013 (following completion of Residential Water Metering Program)
Complete Water System Audit	2013 (following completion of Residential Water Metering Program)
Retrofit Upon Resale	Starting in 2014 per SB 407
CII Water Conservation Representative	Position filled in January 2010
Identification of Largest CII Water Users and Potential Water Conservation Measures	FY 2010/11
CII Toilet Replacement Program	Program implemented in FY 09/10
CII Washing Machine Rebate Program	TBD
Join California Urban Water Conservation Council (CUWCC)	Recommended in FY 10/11 budget
Xeriscape Landscape Rebate for New Homes	TBD
Hot Water Recirculation System Rebate	TBD
Programmable Irrigation Controller Rebate	TBD
Weather-Based Irrigation Controller Rebate	TBD
Turf Replacement Rebate ("Cash for Grass")	TBD
Landscape Water Audit and Budget Program	TBD

(a) Proposed implementation dates as of May 2010.

Metering with Commodity Rates

As described above, the City has begun the implementation of a residential water metering program which will provide for the installation of water meters on all residential connections by March 2013. In conjunction with this residential metering program, the City implemented a quantity-based metered water rate structure for all of its metered customers in 2010. This metering program is expected to reduce residential water demand by about 10 percent due to increased water use awareness by residential customers. Also, by having all of its customers metered, the City will be better able to measure the success of its overall water conservation program and improve its management of available water resources.

Implementation of a Tiered (Increasing Block) Water Rate Structure

As discussed above, as part of the Residential Metering Program, the City implemented a quantity-based metered water rate schedule in 2010. This metered water rate schedule consists of a fixed "Standby Charge" based on meter size plus a "Quantity Charge" per each unit of water used (e.g. per every 100 cubic feet of water used). The rate for the "Quantity Charge" is the same no matter how much water is used.

Tiered (increasing block) water rates are used by many agencies to further encourage water conservation and discourage water waste. For example, the City of Redwood City has a tiered rate structure for its residential customers, which includes a basic monthly service fee and a water consumption fee. The water consumption fee increases as water use increases. Table 4-3 presents the City of Redwood City's residential water rate structure as an illustrative example of an increasing, tiered block rate structure.

Table 4-3. Example of Tiered Water Rate Schedule for Residential Customers[a]

Basic Service Charge	Water Consumption Charge[b]
$16.53 monthly (same for all residential meter sizes)	0-10 units = $2.20/unit 11-25 units = $2.80/unit 26-50 units = $4.57/unit 51+ units = $6.45/unit

[a] Based on City of Redwood City residential water rates effective July 22, 2009.
[b] 1 unit = 100 cubic feet of water = 748 gallons

Using the City of Redwood City water rates as an example, residential customers would pay $2.20 per unit ($0.0029 per gallon) for the first 10 units of water they use, $2.80 per unit ($0.0037 per gallon) for the next 15 units of water they use, and so on.

The City has developed a quantity-based rate structure for the residential water metering program. Tiered water rates, as described above, should be implemented as soon as possible for all customers to further encourage water conservation and discourage water waste.

System Water Audit and Prioritized Leak Detection Program

A water audit determines the amount of water lost from a distribution system due to leakage and the cost of this loss to the utility. Water audits balance the amount produced with the amount billed and account for the remaining water (loss). Comprehensive audits can give the water utility a detailed profile of the distribution system and water users, allowing easier management of resources and improved system reliability. It is an important step towards water conservation and, linked with a leak detection plan, can save the utility a significant amount of water, money and time.

Elements of the audit would include the following:

- Record of the amount of water produced;
- Record of the amount delivered to metered users;
- Record (or estimate) of the amount delivered to unmetered users;
- Calculate the amount of water loss (balance of water, including leaks); and
- Measures to address water loss (leaks and other unaccounted-for (i.e., non-measured) water uses).

Benefits of an audit include improved knowledge and documentation of the distribution system including problem and risk areas. The audit also becomes a valuable tool to manage resources, by getting a better understanding of what is happening to the water after it leaves the well sites and treatment plant. Leak detection programs are effective ways to minimize leakage and to fix small problems before they become major ones.

According to the American Water Works Association, these programs lead to reduced water losses, financial improvement, increased knowledge of the distribution system, more efficient use of existing supplies, safeguarding public health and property, improved public relations, reduced legal liability, and reduced disruption to customers.

In recent years, the City has performed two pilot leak detection programs in isolated portions of the City. Results from these leak detection programs indicated no leaks. Since most of the City's customers are not currently metered, it is impossible to determine the extent of leakage within the entire water system. However, once the City is completely metered in March 2013, the City will be able to monitor and track actual water usage by its customers and compare it to total water production. The difference between the metered usage and total production will be the unaccounted-for water, which will include unmetered uses and leakage. Therefore, a water system audit and formal leak detection program will be implemented by the City following completion of its residential water metering program in March 2013.

Retrofit Upon Resale

In accordance with plumbing codes, all new homes constructed after 1992 are required to have water conserving fixtures (e.g., low flow toilets). Starting in 2011, both new residential and non-residential construction will be required to comply with the California Green Building Standards Code requiring low-flow fixtures (including high efficiency toilets and low flow faucets and showerheads). The City has offered low-flow plumbing fixtures to its customers as part of its residential water surveys and other water conservation events and educational seminars. In addition to these types of programs, some water agencies have implemented "Retrofit Upon Resale" ordinances which require that older, high-water-use plumbing fixtures be replaced with low-flow plumbing fixtures whenever a property is sold.

For most agencies, the ordinance requires that all buildings, prior to a change in property ownership, be certified as having water-conserving plumbing fixtures in place. Also, the ordinances apply to all residential, commercial, and industrial water customers. Generally, the seller is responsible for ensuring that the property is in compliance, and for filing a Water Conservation Certificate with the water agency prior to the close of escrow. Agencies with such an ordinance in place include: City of San Diego, City of Los Angeles, City of San Francisco, City of Santa Monica, Monterey Peninsula Water District, and North Marin Water District.

In October 2009, SB 407 was passed in California which established statewide requirements for installation of water-conserving plumbing fixtures in conjunction with building improvements and property transfers. The City will need to comply with these requirements. Key dates and requirements are as follows:

- On or after January 1, 2014, for all building alterations or improvements to single family residential real property, that water-conserving plumbing fixtures replace other non-compliant plumbing fixtures as a condition for issuance of a certificate of final completion and occupancy or final permit approval by the local building department
- On or after January 1, 2014, for all building alterations or improvements to multi-family residential real property and commercial real property, that water-conserving plumbing fixtures replace other non-compliant plumbing fixtures as a condition for issuance of a certificate of final completion and occupancy or final permit approval by the local building department
- On or before January 1, 2017, that all noncompliant plumbing fixtures in any single-family residential real property shall be replaced by the property owner with water-conserving plumbing fixtures
- On or after January 1, 2017, that a seller or transferor of single-family residential real property, multifamily real property, or commercial real property disclose to a purchaser or transferee specified requirements for replacing plumbing fixtures, and whether the property includes noncompliant plumbing
- On or before January 1, 2019, that all non-compliant plumbing fixtures in multi-family residential real property and commercial real property, be replaced with water-conserving plumbing fixtures

The City will need to comply with the requirements of SB 407.

Water Conservation Programs for Commercial, Industrial and Institutional (CII) Customers

The following water conservation programs are geared towards the City's CII customers.

CII Water Conservation Representative

In January 2010, the City's Water Conservation Section was able to fill the commercial, industrial, and institutional (CII) conservation representative position. Work will begin following completion of position probationary issues and training.

Identification of Largest CII Water Users and Potential Water Conservation Measures

As discussed above, the City recently filled the CII representative position in its Water Conservation Section. The Water Conservation Section has identified the largest water users and plans to work with them to identify potential water conservation programs within their facilities. It was noted that two of the City's largest water users are chicken processing facilities which are mandated by various regulations to use a certain quantity of water per chicken processed; therefore, any water conservation methods recommended would need to meet and be consistent with applicable regulations.

CII High-Efficiency Washing Machine Rebate Program

In November 2007, the City implemented a residential high-efficiency washing machine rebate program to supplement rebates provided by PG&E. In the future, pending funding availability, the City will consider extending the rebate program to include high-efficiency washing machines in commercial, industrial, and institutional facilities (e.g., laundromats, schools, hospitals).

CII Toilet Replacement Program

As described in the Metro Plan Update Phase 1 Report, the City has a residential toilet retrofit rebate program which it implemented in 2006. To date, the program has been very successful with the replacement of over 600 toilets. In 2009, this program was extended to include commercial customers.

Join California Urban Water Conservation Council (CUWCC)

The City is a signatory to the CUWCC Memorandum of Understanding (MOU) regarding water conservation. However, the City is not an active member in CUWCC. Membership in CUWCC would provide the City and the City's Water Conservation staff with numerous resources and benefits including the following:

- Participation in joint projects and pilot programs with other water suppliers;
- Attendance at water conservation workshops and training sessions;
- Assistance with BMP/DMM implementation; and
- Facilitation with annual reporting of BMP/DMM implementation.

CUWCC annual membership dues for water retailers are based on an administrative fee, connection charge, and volumetric charge. Table 4-4 provides an estimate of the annual dues calculation based on the City's 2009 water system operations.

Table 4-4. CUWCC Annual Dues Estimate based on City's 2009 Operations

Charge	Charge Calculation[(a)]	Total Annual Charge
Administrative Fee	Retail Agencies with 3,001 or More Connections = $2,321	$2,321
Connection Charge	$0.0260 x Number of Connections = $0.0260 x 131,000 connections	$3,406
Volumetric Charge	$0.0325 x Water Demand, af/yr = $0.0325 x 157,817 af/yr	$5,129
	Total Estimated Annual Membership Dues	$10,856

(a) Based on CUWCC's 2010 Rate Structure and Schedule.

The City understands the importance and benefits of membership in CUWCC and will join as soon as the budget allows.

Other Potential Future Water Conservation Programs

The City should also consider implementation of the following types of water conservation programs.

Xeriscape Landscape Rebate for New Homes

The City is working with several developers to encourage xersicape landscaping be used for model homes in new developments to demonstrate the benefits of xeriscape landscaping. A rebate program would provide new homeowners with a rebate (amount to be determined) if they choose to install a water-conserving xeriscape landscape in-lieu of a higher-water-use, traditional landscape (e.g., turf).

Hot Water Recirculation System Rebate

Hot water recirculation systems and instant hot water systems are becoming more popular in homes. These types of systems, which provide for immediate hot water when the tap is turned on, are not only convenient and time-saving, but also water-saving. This is because cold water is not wasted while waiting for hot water. Such systems vary in price depending on the type of system installed. Offering a rebate to customers who wish to install such a system in their homes would encourage more customers to do so and decrease water waste.

Irrigation Controller Rebate

As previously discussed in the Metro Plan Update Phase 1 Report, the City has been investigating the potential for developing a rebate program for customers who install weather-based irrigation controllers. Weather-based irrigation controllers are typically equipped with computer systems which link to local weather stations and control irrigation frequency and duration based on actual climate conditions. Such controllers increase irrigation efficiencies by not watering as much during colder, wetter periods, while optimizing water use during hotter and drier periods. Such controllers would be especially useful for customers with larger landscapes.

In the future, the City may consider a rebate for the installation of a programmable irrigation controller, which has the ability to be set to the City's water schedule and can be set to cycle more than once during a watering schedule day.

Turf Replacement Rebate ("Cash for Grass")

A large portion of a property's annual water use can be attributed to outdoor water uses, and turf irrigation is typically the largest part of outdoor water use. It is estimated that over half of a home's annual water use is used for landscape irrigation. Several water agencies in California and Nevada (North Marin Water District, City of Roseville, City of Arroyo Grande, and Southern Nevada Water Authority) have implemented turf replacement rebate programs, also known as "Cash for Grass" programs. These programs consist of rebates for existing property owners who choose to replace their turf landscaping with water conserving landscaping or synthetic turf.

One such program is North Marin Water District's "Cash for Grass" program which offers a cash rebate to its residential customers in return for reducing the amount of lawn area in their landscapes. The District pays $100 per 100 square feet of regularly-irrigated lawn area removed or amount of lawn area replaced with synthetic turf. The rebate is limited to $1,000 for single-family residences, $200 for townhomes or condominiums, and $100 for apartments. The District will also rebate "Cash for Grass" participants 25 percent of the costs of District-approved mulch up to $100.

Landscape Water Audits and Budget Program

This program would involve performing audits for large landscape areas to make sure that water is being applied efficiently to help reduce water use. The audit would include a "catch can" test, flow tests, an irrigation inspection and a review of the irrigation schedule. Based on the audit, a budget can be developed for each site based on the calculated area and local evapotranspiration data. The City of Redwood City has developed such a program and has developed a budget-based tiered rate schedule for their landscape irrigation connections. Sites that stay within their site-specific irrigation budget are charged at a Tier 1 rate; however, any water use above the site-specific irrigation budget is charged at a higher Tier 2 rate. The program has been very successful in getting homeowner's associations to pay close attention to their irrigation water use and work closely with their landscape contractors to optimize irrigation system operations and schedules.

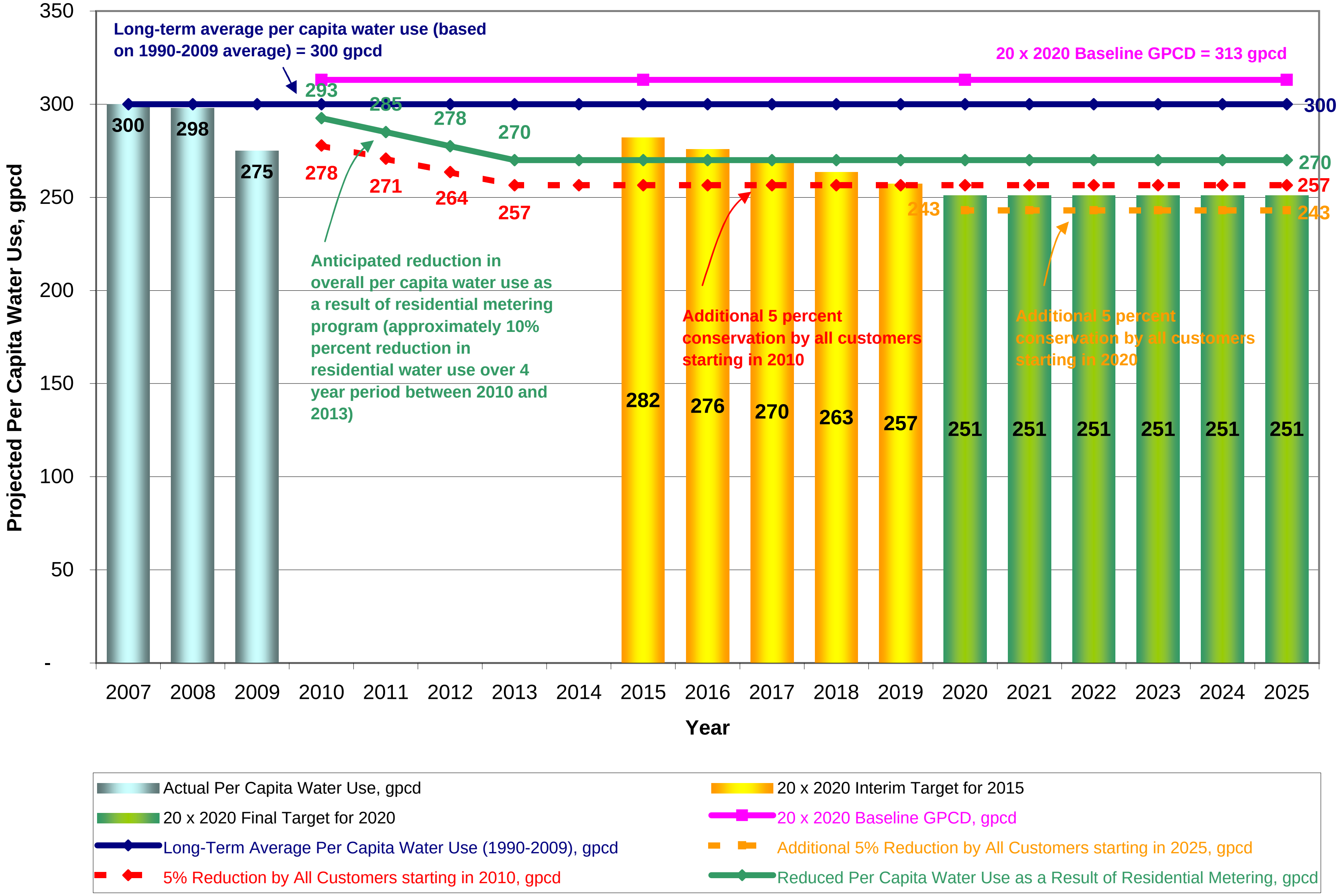
RECOMMENDED WATER CONSERVATION PRIORITIES

While all of the proposed water conservation measures discussed in this chapter and listed in Table 4-2 should be implemented, based on the City's water demand patterns, the biggest opportunities for water conservation are related to the reduction of outdoor water use, particularly landscape and turf irrigation, by all customers. Several potential measures related to outdoor water use reduction are discussed in this chapter. They include the following:

- Xeriscape Landscape Rebate for New Homes;
- Programmable Irrigation Controller Rebate;
- Weather-Based Irrigation Controller Rebate;
- Turf Replacement Rebate ("Cash for Grass"); and
- Landscape Water Audit and Budget Program.

These conservation measures, in addition to the implementation of a tiered water rate structure should be implemented as soon as possible to encourage water conservation and discourage water waste by the City's customers, minimize projected future water demands, and reduce the need for future new water supplies.

Figure 4-1. Projected Future Per Capita Water Use



CHAPTER 5. FUTURE GROUNDWATER

This chapter presents a description of the City's proposed future groundwater use, including proposed groundwater pumpage to help meet projected future water demands, and required maintenance and expansion of the City's intentional groundwater recharge program to minimize future groundwater level declines and bring the City's groundwater operations into balance (whereby groundwater pumpage equals groundwater recharge) by 2025.

FUTURE GROUNDWATER OBJECTIVES, GOALS, AND POLICIES

As described in Chapter 3, as part of the City's future water supply program, the City has proposed a number of specific objectives, goals and policies. The specific objectives, goals and policies related to groundwater include the following:

Groundwater Objectives

- Balance the City's groundwater use to help minimize further groundwater level declines and potential water quality degradation;
- Maintain adequate groundwater pumping capacity to meet demands during dry periods and emergencies, when surface water supplies may be reduced; and
- Implement a groundwater banking program to allow for banking of surplus available water supplies in wet years for later extraction in dry years.

Groundwater Goals

- Balance the City's impact on groundwater basin storage by 2025 (e.g., recharge equal to pumpage);
- Assist regional stakeholders in restoring groundwater levels; and
- Maximize intentional groundwater recharge, using available, remaining surface water supplies (e.g., surface water supplies not required for direct treatment and use).

Groundwater Policies

- Balance groundwater pumping to not exceed intentional recharge plus natural inflow plus subsurface inflow;
- Replenish groundwater basin storage through intentional recharge activities when surface water supplies are available to help restore groundwater levels to historical levels;
- Work with FID and FMFCD to construct and maintain additional recharge basins to take advantage of available surface water supplies;
- Construct dedicated recharge facilities;
- Require new development to mitigate for groundwater impacts (both quantity and quality);

- Further develop partnerships with FID, Clovis and others to maximize available water resources;
- Provide additional staff and program-specific financial resources required to implement and manage the City's groundwater resources and groundwater use program (e.g., environmental compliance manager);
- Develop a City-wide groundwater quality management plan (to maintain and monitor present and future plume management and cleanup activities);
- Support the elimination of point sources for groundwater contamination (e.g., nitrate); and
- Enforce the existing sewer ordinance requiring all new connections to be sewered (to eliminate potential new point contamination sources).

CURRENT GROUNDWATER USE AND RECHARGE ACTIVITIES

Summary of Current Groundwater Wells and Pumpage

The City currently operates about 270 groundwater wells located throughout the City's service area. Groundwater pumpage in 2009 was 138,254 af/yr, which was used to meet about 88 percent of the City's water demands (the remaining demand was met using treated surface water—see Chapter 6). Since 1990, groundwater pumpage by the City has averaged about 141,600 af/yr, with a maximum groundwater pumpage of about 165,500 af/yr in 2002. Figure 5-1 shows the City's groundwater pumpage since 1990.

Current Groundwater Recharge Activities

As described in the Metro Plan Update Phase 1 Report[1], the City has an extensive intentional groundwater recharge program. Surface water supplies are recharged to the groundwater basin at a number of recharge facilities located throughout the greater Fresno area. These facilities are owned and operated by a number of different agencies, including the City of Fresno, City of Clovis, FID and FMFCD.

Since 1990, total intentional groundwater recharge by the City has averaged about 48,600 af/yr, with a maximum intentional groundwater recharge of 61,970 af/yr in 2003. However, in 2006 and 2007, the intentional recharge was below 40,000 af/yr, and only increased in 2008 and 2009 due to increased recharge at the FMFCD basins. In 2008, recharge at the City's Leaky Acres facility was only 5,136 af/yr, which was the lowest recharge ever at that facility. In 2009, recharge at Leaky Acres increased to 9,517 af, but was still well below historical recharge amounts. As described in Chapter 3, this intentional groundwater recharge is in addition to the City's proportionate share of natural groundwater recharge within the SOI (including deep percolation, seepage from major canals, and net subsurface inflow which have been estimated to be 17,000 af/yr, 15,500 af/yr, and 21,100 af/yr, respectively) (see additional discussion below).

[1] See Chapter 5 of the Phase 1 Report and Table 5-19 of the Phase 1 Report for historical groundwater recharge quantities.

As shown on Figure 5-1, since 1990, in each year the annual intentional recharge (together with current estimates for deep percolation, seepage from major canals, and net subsurface inflow) has been less than the annual quantity of groundwater pumped by the City, resulting in "unbalanced" groundwater operations in every year. Due to these unbalanced groundwater operations, over the last twenty years, the City has pumped about 785,000 acre-feet more than has been recharged, resulting in groundwater level declines and a reduction in groundwater basin storage.

Recharge Activities at Leaky Acres

Recharge at the City's Leaky Acres recharge facility has historically been as high as 30,373 acre-feet in 1992. However, since then, annual recharge at Leaky Acres has declined, and was only 5,136 acre-feet in 2008. In 2009, recharge at Leaky Acres increased to 9,517 af, but was still well below historical recharge amounts. This decline in recharge at Leaky Acres is due to maintenance issues at the facility (which prevent full utilization of the available recharge area and adversely impacts percolation rates at the site) and a reduced delivery season. The City is in the process of making maintenance of this existing facility a higher priority, to more fully utilize the potential recharge capabilities at the site, and at a minimum, maintain existing recharge capabilities, and, if possible, restore past recharge capabilities.

Recharge Activities at FMFCD Recharge Facilities

Prior to the 2000 recharge program, the City established a goal for the FMFCD of 30,000 acre-feet of recharge with a 2 percent increase per year for each of the following years, with a maximum goal of 40,000 af of recharge. In 2000, FMFCD's recharge goal was surpassed (34,983 acre-feet)[2]. However, in subsequent years, actual recharge was below recharge goals, and was as low as 16,050 af in 2007[3]. In 2008, recharge at the FMFCD basins increased significantly to 32,796 af. This increase was reportedly due to increased maintenance activities at the FMFCD basins in 2008. In 2009, recharge at the FMFCD basins was 31,968 af.

In April 2008, the FMFCD prepared a "*Report on Groundwater Recharge Activity in District Basins for 2007 Recharge Year*" (a copy is provided in Appendix C of this Phase 2 Report). The report outlined several reasons why recharge volumes have declined in recent years at FMFCD facilities. They are summarized as follows:

- Shortened water delivery season due to below-average snow pack (estimated loss of 7,500 acre-feet of recharge);
- More conservative canal operations to reduce spills to the San Joaquin River, use of basin for spills rather than delivering maximum volume to basins, and providing downstream capacity for surface water treatment plants in the event they do not take estimated deliveries (estimated loss of 1,000 acre-feet of recharge);
- Construction, maintenance or excavation activities in high-percolation rate sites (estimated loss of 7,500 acre-feet of recharge);

2 City of Fresno Recharge Statistics 1985 to 2009.

3 City of Fresno Recharge Statistics 1985 to 2009.

- Drop off in percolation rates at some basins due to less frequent silt removal and more economical maintenance scheduling of the basins (estimated loss of 2,000 acre-feet of recharge); and
- Conversion of good recharge basins to park sites (e.g., Basins XX and CN) (estimated loss of 2,000 acre-feet of recharge).

FUTURE GROUNDWATER USE

Projected Future Groundwater Pumpage

As described previously in Chapter 3, the City's future water supply plan continues to include groundwater as the primary water supply; however, in the future, as use of other supplies is increased (particularly treated surface water), the percentage of groundwater use decreases. As described above, in 2009, groundwater made up about 88 percent of the City's supply. Based on the City's future water supply plan, in 2025 groundwater will make up about 37 percent of the City's total supply.

As shown in Figure 5-2, in the coming years before expansion of the City's surface water treatment capacity, groundwater will continue to be the City's primary water supply source. In the years between now and 2025, a maximum groundwater pumpage of 152,450 af/yr occurs in 2014, the year before completion of the proposed new Southeast SWTF. This maximum groundwater pumpage is no greater than historical groundwater pumpage by the City[4], and is therefore, assumed to be feasible, assuming additional groundwater recharge facilities are also constructed (see below). Following completion of the new Southeast SWTF in 2015 and expansion of the Northeast SWTF in 2020, groundwater pumpage will range from 80,900 af/yr to 108,300 af/yr through 2025.

To maintain current groundwater pumpage quantities, it is anticipated that a number of existing wells will need to be replaced and that new wells will need to be constructed. A detailed description of the number and location of new wells is provided in Chapter 9 of this Phase 2 Report.

Projected Groundwater Quality and Treatment Needs

Groundwater within the Kings Subbasin generally meets primary and secondary drinking water standards for municipal water use. However, the groundwater basin is threatened by chemical contaminants that affect the City's ability to fully use the groundwater basin resources without some type of wellhead treatment in certain areas. Some of the major contaminant plumes include 1,2-dibromo-3-chloropropane (DBCP), ethylene dibromide (EDB), trichloropropane (TCP), other volatile organic compounds (VOCs) like trichloroethylene (TCE) and tetrachloroethylene (PCE), nitrate, iron, manganese, radon, and chloride.

[4] The City's maximum annual groundwater pumpage occurred in 2002, when groundwater pumpage by the City totaled 165,542 af.

As discussed in the Phase 1 Report, a number of the City's wells are currently being treated or blended to address various contaminants. Thirty (30) active wells and eight (8) inactive wells have current wellhead treatment systems (either granular activated carbon (GAC) or packed tower aeration (PTA)) to remove either DBCP or TCE. Also, several of the wells are being blended to address high nitrate concentrations[5]. There are also a number of additional wells which will probably require wellhead treatment, or will have to be taken out of service, due to the presence of TCP[6]. While no current MCL exists for TCP, DPH is very concerned and the City has identified 37 existing City wells with TCP concentrations that exceed DPH's action level of 0.005 ppb. These 37 wells represent about 14 percent of the City's 270 current active wells, and the potential loss of these wells would equate to a loss of about 25 mgd in groundwater production capacity[7].

In addition to the contaminants of concern identified in the Phase 1 Report, methyl tert-butyl ether (MTBE) has been detected in several City wells. MTBE is a gasoline additive that has become a contaminant of concern in California and throughout the United States as a result of leaking underground gasoline storage tanks. The City is in the process of evaluating the situation and deciding how to move forward to address the issue. Due to the preliminary nature of the current on-going evaluations, groundwater treatment costs to address MTBE have not been included in this Phase 2 Report.

Any future groundwater wells should be located in areas that minimize the need for special design, or wellhead treatment, to minimize capital and operations and maintenance costs; however, wells could be designed so that groundwater in these areas of concern can be used. These wells would need to be monitored closely, with special attention paid to established Maximum Contaminant Levels (MCLs).

Table 5-1 provides a summary of groundwater contaminants and treatment alternatives for the City's wells as outlined by Carollo Engineers in their January 2007 Technical Memorandum 1.4 Groundwater Contaminants and Treatment Alternatives (a copy of which is provided in Appendix B of this Phase 2 Report).

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[5] See Table 5-19 in the Phase 1 Report for a list of the City's active wells with wellhead treatment systems.

[6] See Table 5-20 in the Phase 1 Report for a list of City wells with TCP concentrations exceeding the current action level of 0.005 ppb.

[7] Based on actual production of these wells operating during a maximum day condition.

Table 5-1. Groundwater Contaminants and Treatment Alternatives[a]

Contaminant	Treatment Alternative							
	Air Stripping	Granular Activated Carbon	Advanced Oxidation[b]	Ion Exchange	Reverse Osmosis	Coagulation Filtration/ Oxidation Filtration	Single Use Media Adsorption	Biological Reduction
Organics								
1,1 DCE	✔ [c]	✔ [c]	✔					
1,2 DCP	✔ [c]	✔ [c]	✔					
1,2,3-TCP	✔	✔	✔					
Cis 1,2-DCE	✔ [c]	✔ [c]	✔					
DBCP		✔ [c]	✔					
EDB		✔ [c]	✔					
PCE	✔ [c]	✔ [c]	✔					
TCE	✔ [c]	✔ [c]	✔					
Inorganics								
Arsenic				✔ [c]	✔ [c]	✔ [c]	✔	
Chromium				✔ [c]	✔ [c]	✔ [c]	✔	
Nitrate				✔ [c]	✔ [c]			✔
Hydrogen Sulfide	✔	✔						
Iron					✔	✔		
Manganese					✔	✔		
Radionuclides								
Radon	✔	✔						

(a) Source: Table 6, Metropolitan Water Resources Management Plan Update Summary of Contaminants and Treatment Alternatives, City of Fresno, Technical Memorandum 1.4 Groundwater Contaminants and Treatment Alternatives, prepared by Carollo Engineers, January 2007.
(b) Emerging technology.
(c) Best Available Technology (BAT) according to USEPA.

FUTURE GROUNDWATER RECHARGE

As noted previously, one of the City's goals for groundwater use is to balance its groundwater operations by no later than 2025. This means that, ideally, the City's groundwater pumpage will not exceed groundwater recharge based on normal year supply conditions. As noted above, historically the City's groundwater operations have not been balanced and annual groundwater pumpage has historically exceeded annual groundwater recharge in every year (see Figure 5-1).

Groundwater recharge is made up of two components: natural recharge (including subsurface inflow) and intentional recharge. Each of these recharge components is described below.

Natural Groundwater Recharge

For the 1996 Metro Plan, natural recharge was estimated to be 43,000 af/yr. For Phase 1 of the Metro Plan Update, WRIME's work in developing a comprehensive groundwater model for the Fresno region[8] resulted in revised estimates of natural recharge. These revised estimates were 37,000 af/yr for the Fresno SOI (2005), decreasing to 27,000 af/yr by 2025 as additional urbanization occurs (reducing the area available for recharge and the total quantity of deep recharge from rainfall).

For Phase 2 of the Metro Plan Update, WRIME focused its use of the regional groundwater model on just the Fresno SOI, resulting in revised long-term estimates of average natural groundwater recharge components[9]. These estimates are as follows:

- Deep Percolation from Rain and Applied Water: 28,600 af/yr
- Seepage from Major Canals: 26,100 af/yr
- Net Subsurface Boundary Inflow (including San Joaquin River seepage)[10]: 35,600 af/yr

However, these overall estimates represent the entire Fresno SOI area, in which the City is not the only groundwater pumper. Based on projected future groundwater pumpage by the City and others within the SOI area, the City on average will pump about 59 percent of the groundwater within the SOI. Other pumpers, including private groundwater users and other water suppliers, will pump the remaining 41 percent of the groundwater within the Fresno SOI. Therefore, for purposes of this Phase 2 analysis, and to be conservative, only 59 percent of the natural recharge components are assumed to be available to the City. This is summarized in Table 5-2.

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[8] WRIME, IGSM Model Calibration Report, October 2007.

[9] See further discussion on WRIME's focused modeling efforts later in this chapter and in Appendix D of this Phase 2 Report.

[10] Net subsurface boundary inflow is the boundary inflow minus boundary outflow (see Table 5 in Appendix D).

Table 5-2. Estimated Natural Recharge Available to the City

Natural Recharge Component	Long-Term Average Natural Recharge within Fresno SOI[(a)]	Percent of Natural Recharge Available to the City[(b)]	Long-Term Average Natural Recharge Available to the City
Deep Percolation from Rain and Applied Water, af/yr	28,600	59%	17,000
Seepage from Major Canals, af/yr	26,100	59%	15,500
Net Subsurface Boundary Inflow (includes San Joaquin River Seepage), af/yr	35,600	59%	21,100
Total Natural Groundwater Recharge	90,300	59%	53,600

(a) Long-term average deep percolation, seepage and subsurface inflow within the Fresno SOI as estimated by WRIME in focused groundwater modeling performed for Phase 2 of the Metro Plan Update in December 2008 (see additional discussion in Appendix D of this Phase 2 Report).

(b) Proportionate share based on percentage of City groundwater pumpage as compared to overall groundwater pumpage within SOI (long-term average City pumpage = 89,500 af/yr; long-term average total pumpage = 150,700 af/yr; City proportionate share = 89,500 af/yr/150,700 af/yr = 59 percent).

Required Future Intentional Groundwater Recharge Quantities

In 2007, the City's intentional recharge was about 38,100 af/yr. As mentioned above, this was the lowest annual intentional groundwater recharge in the last 18 years. In 2008, the City's intentional recharge increased to 50,434 af/yr, but only because of increased recharge at the FMFCD basins. In 2009, intentional recharge increased somewhat (to 54,617 af/yr) due to some additional recharge at Leaky Acres.

It is assumed that, at a minimum, the 2009 recharge quantity can be maintained in the future. Assuming that the City's groundwater pumpage can be reduced as a result of the proposed additional surface water treatment capacity, the City's existing intentional recharge of 54,600 af/yr is adequate to achieve and maintain a balance of the City's groundwater operations beginning as early as 2015. This is graphically shown on Figure 5-3. However, if the additional surface water treatment capacity proposed for the future is not available, or is delayed for any reason, the required groundwater pumpage will increase and additional intentional recharge will be required to achieve and maintain balanced groundwater operations.

As shown on Figure 5-4, and as described further in Chapter 6, in most years (except possibly in some critically dry years) additional surface water supplies are anticipated to be available to provide for additional intentional groundwater recharge, beyond the quantity required for balanced groundwater operations. By 2025, up to 198,500 af/yr of surface water supplies are available to the City in normal years. As shown in Figure 5-4, 123,400 af/yr is proposed to be treated for direct use, and 32,400 af/yr is needed for intentional recharge, leaving 42,700 af/yr of available surface water supplies that could be intentionally recharged if recharge capacity was available. Since the City's current recharge capacity is estimated at 54,600 af/yr, an additional recharge capacity of 20,500 af/yr (42,700 af/yr + 32,400 af/yr – 54,600 af/yr) would be required to take full advantage of the normal year surface water supplies available in 2025. Based on the City's anticipated average recharge capacity per acre of about 120 acre-feet per acre per year (0.4 acre-feet per acre per day over a 10-month per year operational cycle), this would equate to about 170 acres of additional recharge area. However, it should be noted that if recharge capacity is only 0.2 acre-feet per acre per day (only half of the estimated average), twice as many acres would be required (340 acres).

Nevertheless, if the City has additional groundwater recharge capacity available to store these available surface water supplies, either through the expanded use of existing recharge facilities or the construction of new recharge facilities, this could serve to bring the City's groundwater operations into balance sooner and help restore groundwater levels sooner.

Future Recharge Locations

The need for on-going and, if possible, expanded intentional recharge operations will require enhanced operations and maintenance, and expanded use of existing recharge facilities (if possible), and/or construction of new recharge facilities.

Future Use of Existing Recharge Facilities

As discussed above, the City should make maintenance of the existing Leaky Acres facility a high priority to take advantage of the existing recharge capabilities at the site to maintain existing recharge capabilities, and, if possible, restore past recharge capabilities.

For this Phase 2 Report, Blair, Church & Flynn Consulting Engineers conducted an evaluation of planned future groundwater recharge facilities. Their Technical Memorandum dated July 30, 2008 (see Appendix C) indicated that FMFCD is working with the City of Fresno to identify future recharge sites. However, neither FID nor the City of Clovis has plans to develop future groundwater recharge facilities.[11]

For purposes of this Phase 2 Report, it is assumed that, at a minimum, the 2009 intentional groundwater recharge quantity of 54,600 acre-feet by the City, FMFCD, and FID will be maintained into the future.

New Recharge Facilities

The City is continuously looking for opportunities to expand its groundwater recharge operations through the acquisition of new properties. The availability of additional recharge capacity would provide the City with operational flexibility and allow for additional recharge (beyond that required to balance operations) in years where surplus surface water supplies are available. As discussed in Chapter 8, if the City acquires future new supplies which could be used for groundwater recharge, additional recharge facilities, beyond those discussed above, may be required.

[11] Source: Technical Memorandum prepared by Blair, Church & Flynn Consulting Engineers, July 30, 2008 (see Appendix C).

The City estimates that the average recharge capacity in the City is about 0.4 acre-feet per acre per day over a 10-month per year operational cycle, which equates to about 120 acre-feet per acre per year. This means that every 10 acres of new recharge area can provide for about 1,200 acre-feet per year of additional intentional recharge capacity. However, it should be noted that the actual recharge capacity in specific parts of the City may be more or less that this estimated average.

It is recommended that the City strive to increase its recharge capacity to be able to take advantage of at least the surface water supplies available during normal years. As described above, this would require an additional recharge area of about 340 acres (conservatively assuming a recharge capacity of 0.2 acre-feet per day over a 10-month period, half the estimated Citywide average), and would provide an additional recharge capacity of about 20,500 af/yr, beyond the City's existing recharge capacity of 54,600 af/yr. This would provide the City with additional flexibility for its recharge program and provide the opportunity to help restore groundwater levels to historical levels. This additional recharge capacity could also be used to capture other waters for recharge (e.g., stream group waters).

It may be to the City's advantage to construct smaller, more distributed groundwater recharge basins, or phase the construction of larger basins by purchasing larger properties in smaller increments, with options for future purchase of the entire property, to reduce the impact on both land use planning and required cash flow. Also, it may be possible to expand existing basins where adjoining lands are undeveloped and available for purchase. The facilities required for the conveyance of water supplies to be used for recharge should also be considered in the evaluation of potential future recharge sites.

A potential alternative to new groundwater recharge basins may include the development of an Aquifer Storage and Recovery (ASR) Well System, whereby treated, potable water is injected into the dewatered areas of the groundwater aquifer to directly replenish the aquifer, instead of requiring infiltration from surface basins. New wells could be constructed with both injection and extraction capabilities. Although permitting of ASR well systems has been difficult in the past, an ASR well system requires substantially less land area than a traditional recharge basin, and should be considered as a future option. As a next step, the City should consider the preparation of an ASR feasibility study which identifies the hydrogeologic, water quality compatibility, and regulatory issues and challenges in obtaining approval and implementing such a system.

FUTURE GROUNDWATER RESPONSE

Overview

For this Phase 2 evaluation, WRIME used the Kings Basin Integrated Groundwater Surface Water Model (Kings IGSM) groundwater model developed for the Upper Kings Basin Water Forum, Kings River Conservation District and the City of Fresno (previously described in Chapter 7 of the Phase 1 Report) to perform a focused evaluation of effects the City's proposed water supply plan and the proposed future groundwater operations (as described in this Phase 2 Report) on future groundwater levels and groundwater storage in the Fresno area.

Assumptions

For the Phase 2 groundwater model runs, WRIME incorporated increasing demand projections, combined with assumed annual variations in hydrologic conditions (based on historical hydrologic patterns), to predict the groundwater response (change in groundwater levels and storage) for both "baseline" (without the proposed project) and "with project" (with the proposed water supply project) conditions[12]. Although WRIME utilized the future growth assumptions described in the Phase 1 Report (including assumed future growth beyond the City's current SOI into the 2060 Growth Fringe), and not the revised future growth assumptions that have been used in this Phase 2 Report, the results of WRIME's evaluation are still applicable and are demonstrative of the relative anticipated responses of the underlying groundwater basin within the City's SOI under "baseline" conditions and "with project" conditions.

The "baseline" model runs were based on existing "status quo" water supply operations, using only groundwater and the existing Northeast SWTF (at a capacity of 30 mgd) to meet existing and future demands. The "with project" model runs were based on implementation of the future water supply plan described in this Phase 2 Report, including reduced dependence on groundwater pumpage to meet existing and future demands, increased surface water treatment capacity, increased intentional groundwater recharge, and use of recycled water to meet non-potable demands.

For the Phase 2 groundwater model runs, seepage along the model's northern boundary of the Fresno SOI (along the San Joaquin River between Friant Dam and the Highway 99 crossing) was assumed to be evenly split; 50 percent of the seepage from the San Joaquin River was allocated to the north (to Madera County) and 50 percent was allocated to the south (to the Fresno SOI). No subsurface inflow was allowed to enter into the Fresno SOI area from north of the San Joaquin River, and similarly, no subsurface flow was allowed to leave the Fresno SOI boundary to the north into Madera County. This conservative assumption limits the assumed subsurface inflow from the north to only half of the San Joaquin River seepage, ensuring that the Fresno SOI receives no more than its fair share of subsurface inflows from the river.

A complete description of the model assumptions, runs and results is provided in Appendix D of this Phase 2 Report. A summary of the modeling results is provided below.

Results

The overall results of the WRIME groundwater modeling indicate that the City's future water supply plan, as described in this Phase 2 Report, will have significant beneficial impacts to the groundwater basin underlying the City, especially when compared to the "baseline" status quo condition. This is described and demonstrated in a series of graphics provided in Appendix D, some of which are excerpted in this chapter, which demonstrate the simulated groundwater levels

[12] As described in Chapter 7 of the Phase 1 Report, WRIME also performed model runs "without the proposed project" for the Phase 1 study. Those Phase 1 model runs were based on holding demands constant within various model runs conducted for various future land use scenarios and comparing the model results against the baseline conditions.

for the Fresno SOI under both “baseline” (without the proposed project) and “with project” (with the proposed future water supply project) conditions.

The simulated groundwater levels for the “baseline” condition from 2010 through 2060 are shown on Figures 5a through 5g in Appendix D. The change in simulated groundwater levels from 2005 to 2060 under “baseline” conditions is shown on Figure 7a (included as Figure 5-5 in this chapter). As shown in Figure 5-5, under “baseline” (no project) conditions, groundwater levels underneath the Fresno SOI decline by as much as 80 to 85 feet when compared to 2005 conditions, thus expanding and deepening the existing cone of depression under the Fresno SOI. The resulting groundwater levels in 2060 under these “baseline” (no project) conditions are shown on Figure 5g (included as Figure 5-6 in this chapter).

Such a drop in groundwater levels would have a devastating impact on the City’s groundwater production wells. Figures 5-7 and 5-8 show the impact of the declining groundwater levels in comparison to existing pump bowl depths in the City’s wells in 2025 and 2060, respectively. Wells shown in “green” indicate that the groundwater level is above the pump bowl depth, while wells shown in “red” indicate that the groundwater level is below the pump bowl depth (indicating that the well will not be able to pump water). As shown, there are a significant number of “red” wells. Table 5-3 provides a summary of the number of wells impacted in 2025 and 2060 under the “baseline” condition.

Table 5-3. Summary of Groundwater Level Impacts on City Wells Under “Baseline” Condition

	2025		2060	
	Number of Wells	Percent of Total	Number of Wells	Percent of Total
Number of Wells Where Groundwater Level is Below Pump Bowl Depth	69	26%	188	70%
Number of Wells Where Groundwater Level is 15 feet or Less Above Pump Bowl Depth	36	13%	22	8%
Number of Wells Where Groundwater Level is Greater than 15 feet Above Pump Bowl Depth	161	60%	56	21%
Number of Wells with Insufficient Data	4	1%	4	1%
Totals	270	100%	270	100%

As shown, in 2025, under “baseline” conditions, 26 percent of the City’s wells would not be operational because static groundwater levels are below the current pump bowl elevations, and another 13 percent of the wells would have groundwater levels of 15 feet or less above the pump bowl elevations, indicating that when those wells are turned on and water levels in the well are drawn down, there may not be adequate water in the well to maintain water coverage over the top of the pump bowl. In 2060, the number of wells with groundwater levels below the pump bowl depth increases to 70 percent, and another 8 percent of the wells would have groundwater levels of 15 feet or less above the pump bowl elevations. Tabulations of projected impacts by well are provided in Appendix E.

The simulated groundwater levels for the "with project" condition from 2010 through 2060 are shown on Figures 6a through 6g in Appendix D. The change in simulated groundwater levels from 2005 to 2060 under "with project" conditions is shown on Figure 7b (included as Figure 5-9 in this chapter). As shown in Figure 5-9, under "with project" conditions, groundwater levels underneath the Fresno SOI increase by as much as 40 feet when compared to 2005 conditions, thus eliminating the existing cone of depression under the Fresno SOI. The resulting groundwater levels in 2060 under "with project" conditions are shown on Figure 6g (included as Figure 5-10 in this chapter).

Figure 8 in Appendix D (included as Figure 5-11 in this chapter) shows the change in simulated groundwater levels at 2060 for the "with project" conditions as compared to the "baseline" status quo condition. As shown, throughout the SOI area, simulated groundwater levels are significantly higher for the "with project" conditions, as compared to "baseline" conditions. In the center of the SOI, groundwater levels are up to 105 feet higher under "with project" conditions. These increases in groundwater levels are a direct result of the future water supply plan, and the benefits of this plan are further demonstrated in hydrographs for key well locations within the SOI (see Figures 5-12a and 5-12b, and additional information in Appendix D)[13].

Figures 5-13 and 5-14 show the benefits of these increasing groundwater levels in comparison to existing pump bowl depths in the City's wells in 2025 and 2060, respectively. Wells shown in green indicate that the groundwater level is above the pump bowl depth, while wells shown in red indicate that the groundwater level is below the pump bowl depth. As shown, in comparison to the "baseline" conditions discussed above, very few wells are impacted. Table 5-4 provides a summary of the number of wells impacted at 2025 and 2060 under the "with project" condition.

[13] The well locations for the hydrographs shown in Figures 4-13a and 4-13b are shown on Figure 9a in Appendix D.

Table 5-4. Summary of Groundwater Level Impacts on City Wells Under "With Project" Condition

	2025		2060	
	Number of Wells	Percent of Total	Number of Wells	Percent of Total
Number of Wells Where Groundwater Level is Below Pump Bowl Depth	8	3%	1	0.4%
Number of Wells Where Groundwater Level is 15 feet or Less Above Pump Bowl Depth	16	6%	13	5%
Number of Wells Where Groundwater Level is Greater than 15 feet Above Pump Bowl Depth	242	90%	252	93%
Number of Wells with Insufficient Data	4	1%	4	1%
Totals	270	100%	270	100%

As shown, in 2025, under "with project" conditions, only 3 percent of the City's wells would have groundwater levels below the current pump bowl elevations, and another 6 percent of the wells would have groundwater levels of 15 feet or less above the pump bowl elevations. In 2060, only one well would have groundwater levels below pump bowl depth, with only another 5 percent of the wells with groundwater levels of 15 feet of less above the pump bowl elevations. Tabulations of projected impacts by well are provided in Appendix E.

Thus, the results for the "with project" condition clearly demonstrate that the proposed future water supply plan described in this Phase 2 Report, including reduced dependence on groundwater pumpage to meet existing and future demands, increased surface water treatment capacity, and increased groundwater recharge, significantly improves groundwater conditions (i.e., groundwater levels and storage) under the Fresno SOI, and allows the City to continue operating their production wells.

REQUIRED INFRASTRUCTURE AND COSTS

Additional discussion regarding the required infrastructure, and associated costs, to support this future groundwater supply plan is provided in Chapter 9 of this Phase 2 Report.

Figure 5-1. Historical Groundwater Pumpage vs. Groundwater Recharge

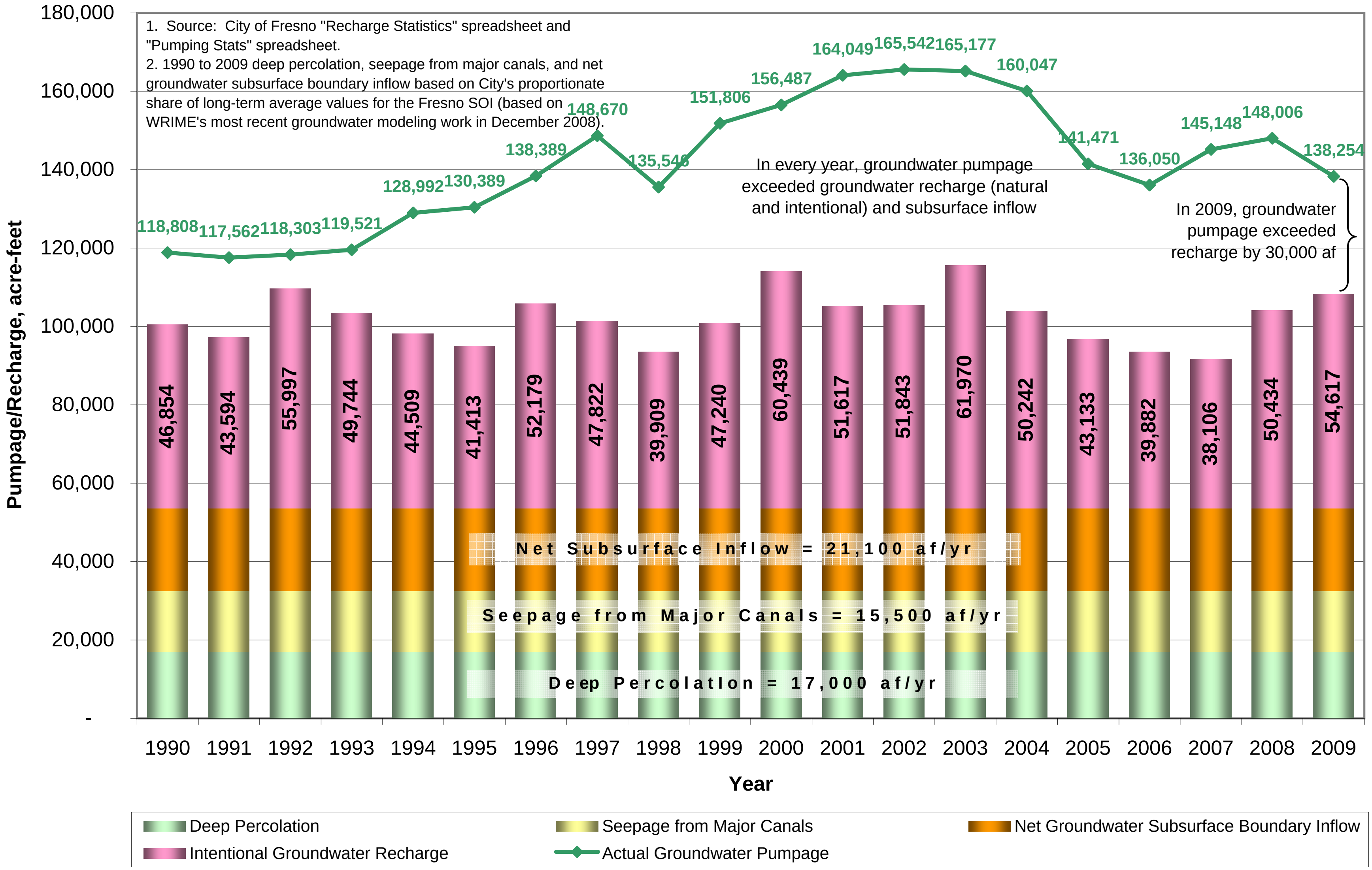


Figure 5-2. Projected Normal Year Annual Water Supply and Demand through 2025

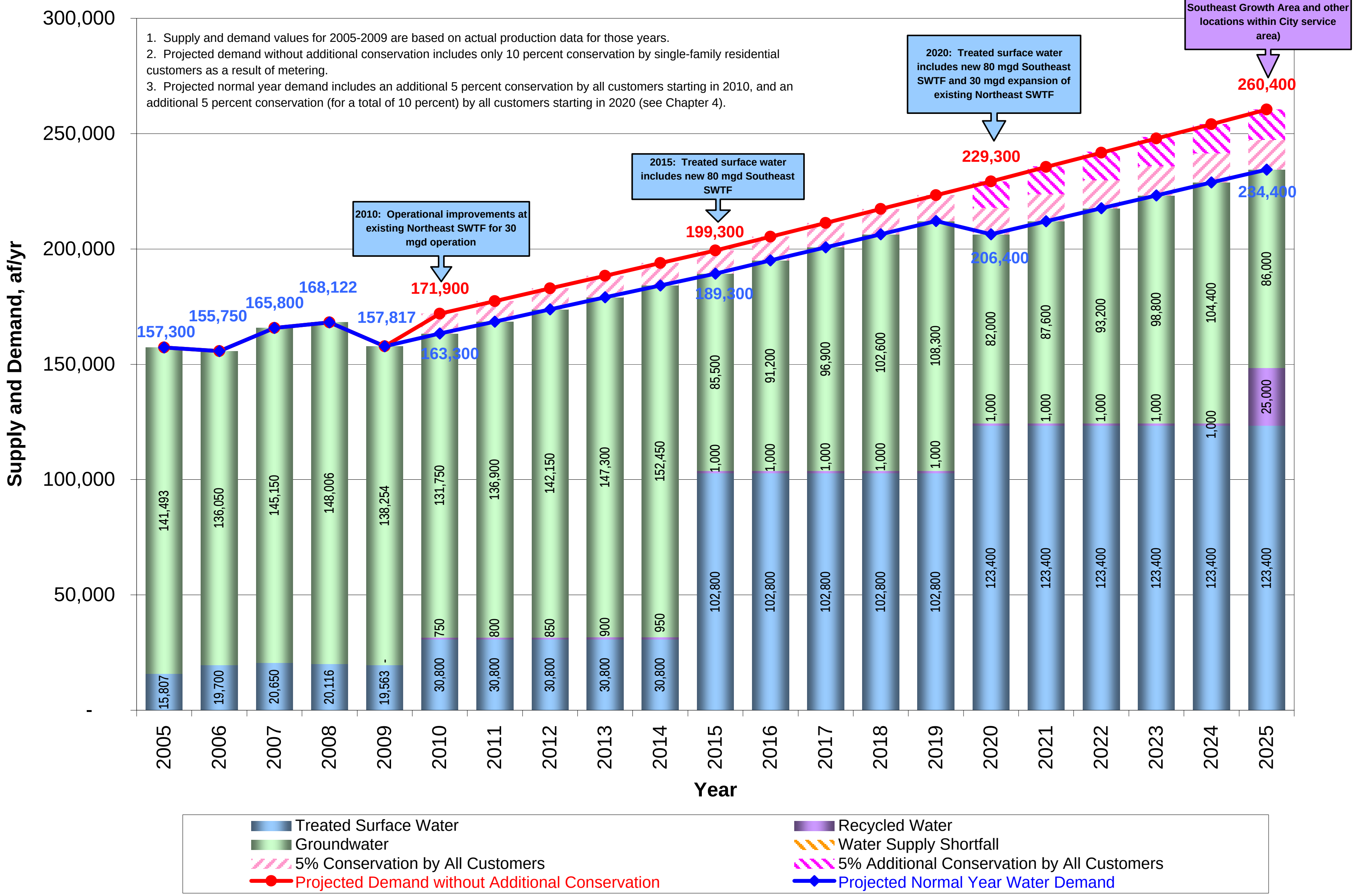


Figure 5-3. City of Fresno Future Groundwater Pumpage vs. Required Recharge for Balanced Groundwater Operations

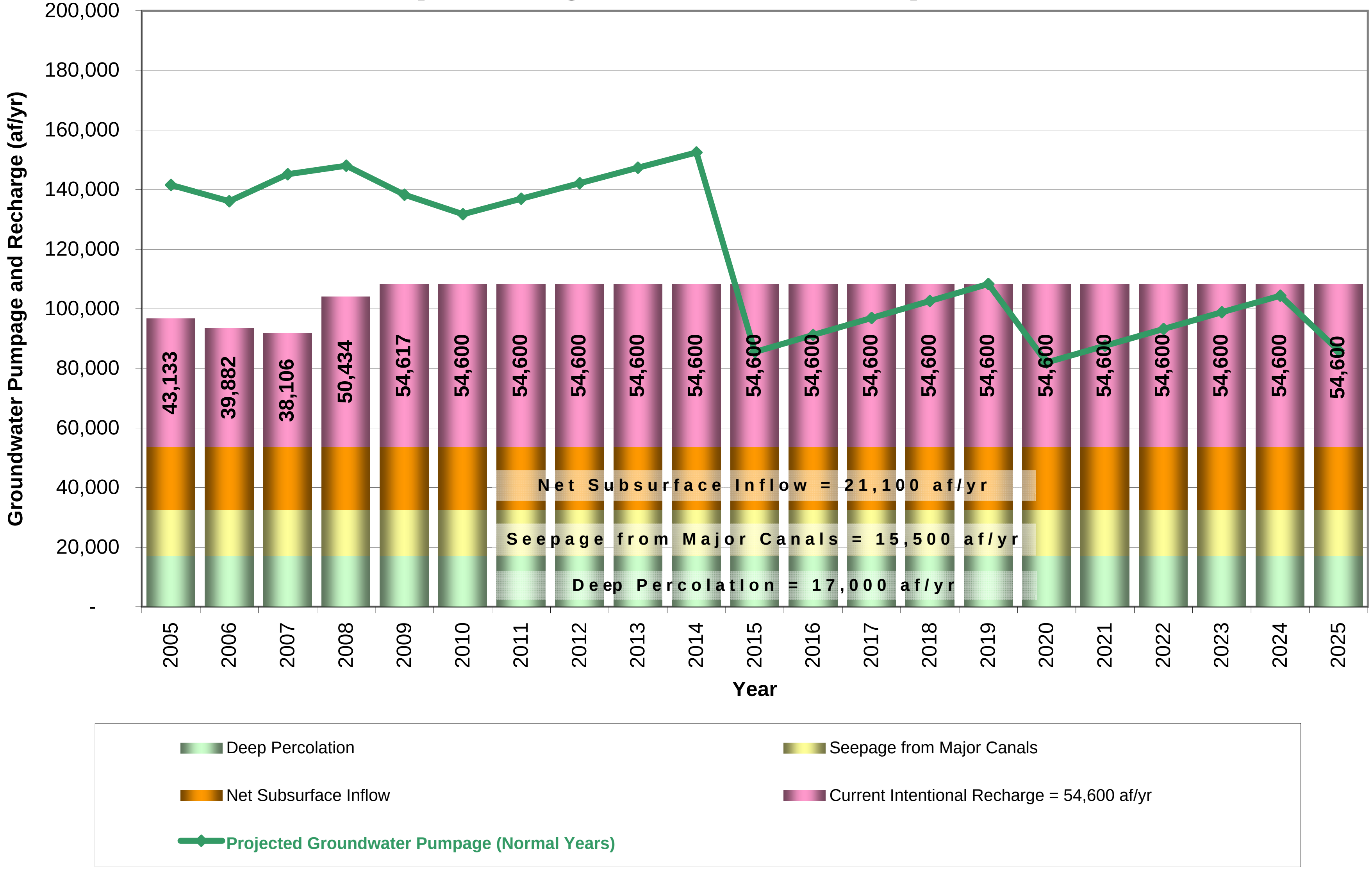
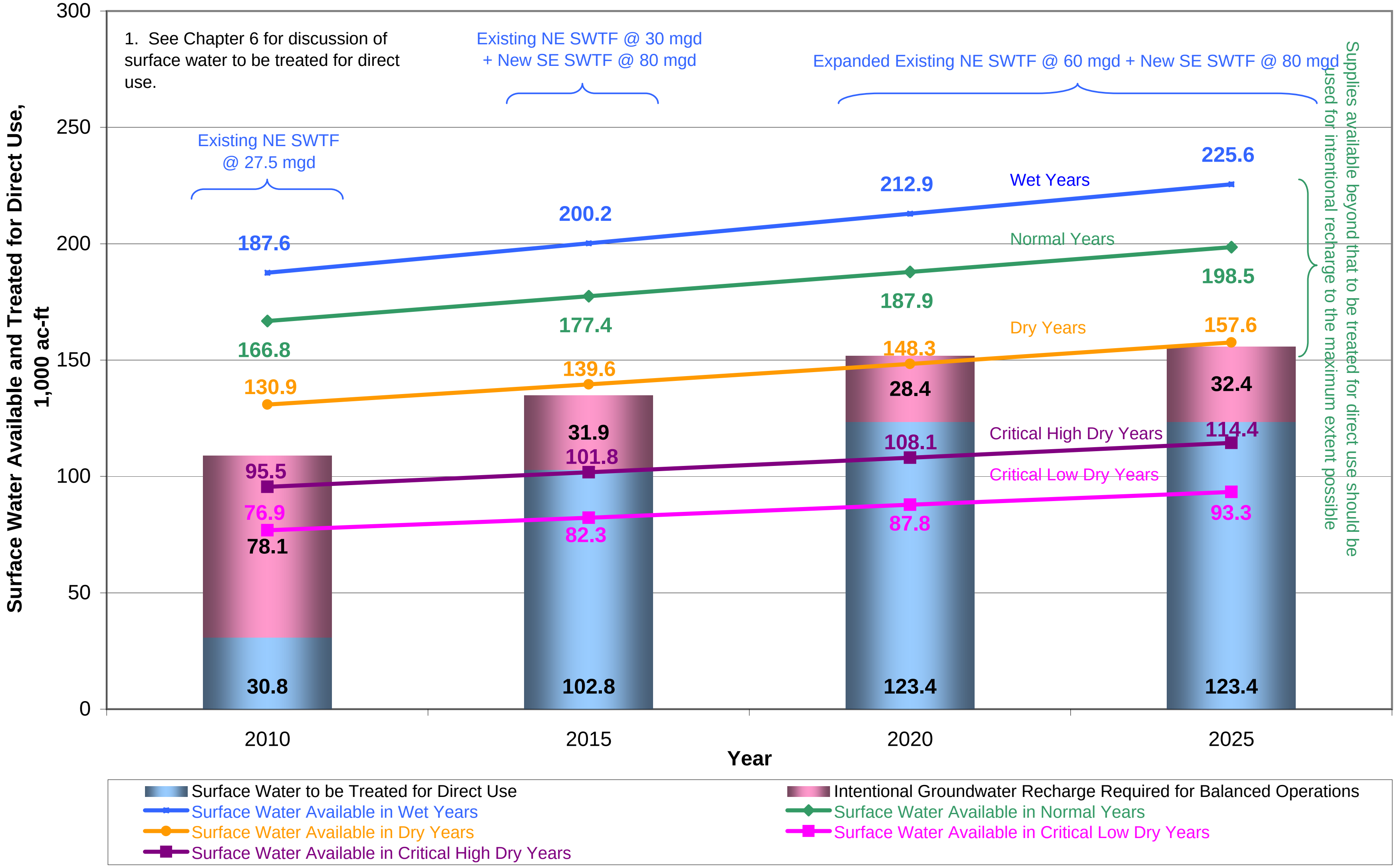
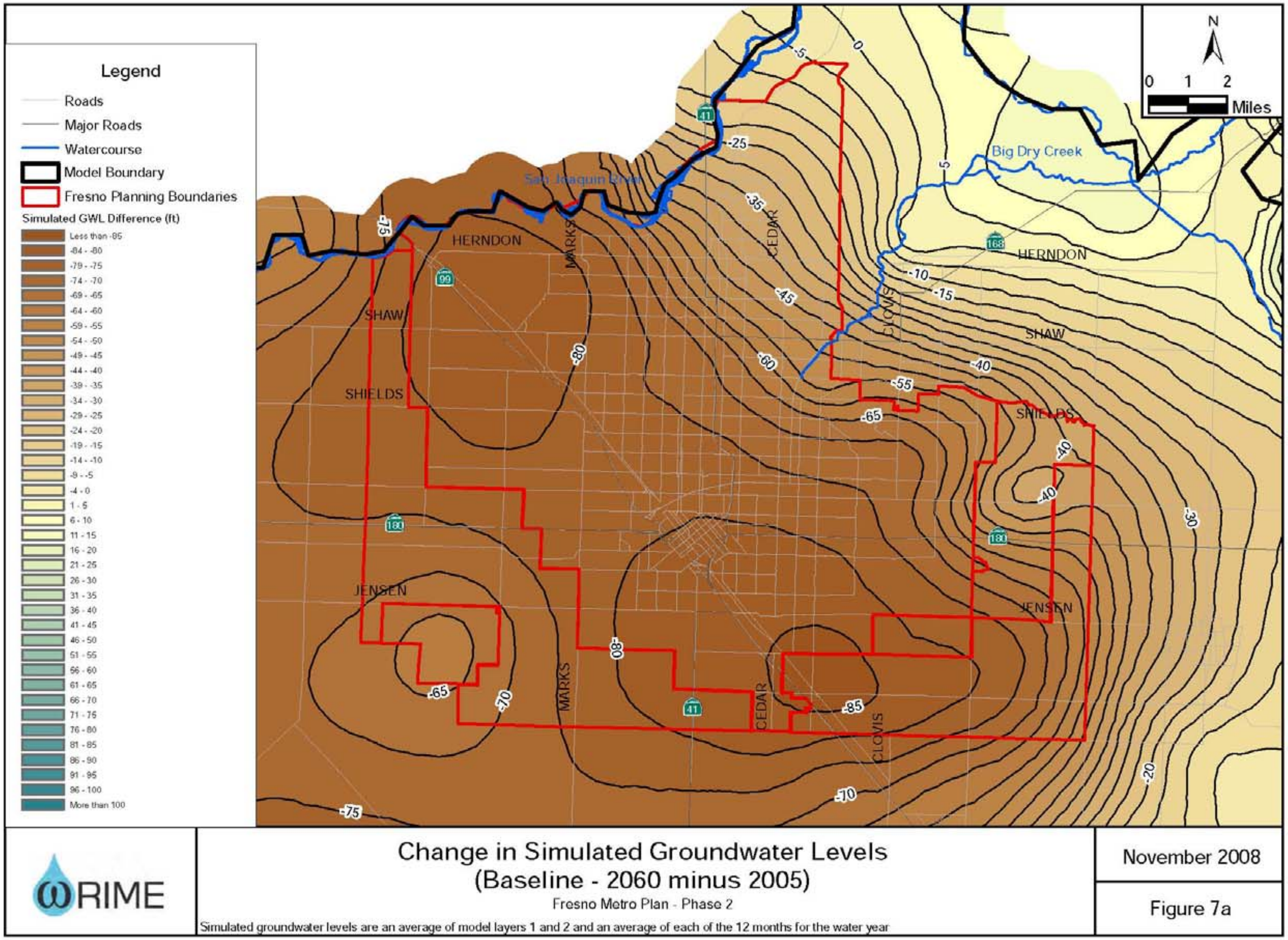


Figure 5-4. City of Fresno Surface Water Available for Intentional Groundwater Recharge





City of FRESNO

Figure 5-5. Baseline Condition: Change in Simulated Groundwater Levels from 2005 to 2060

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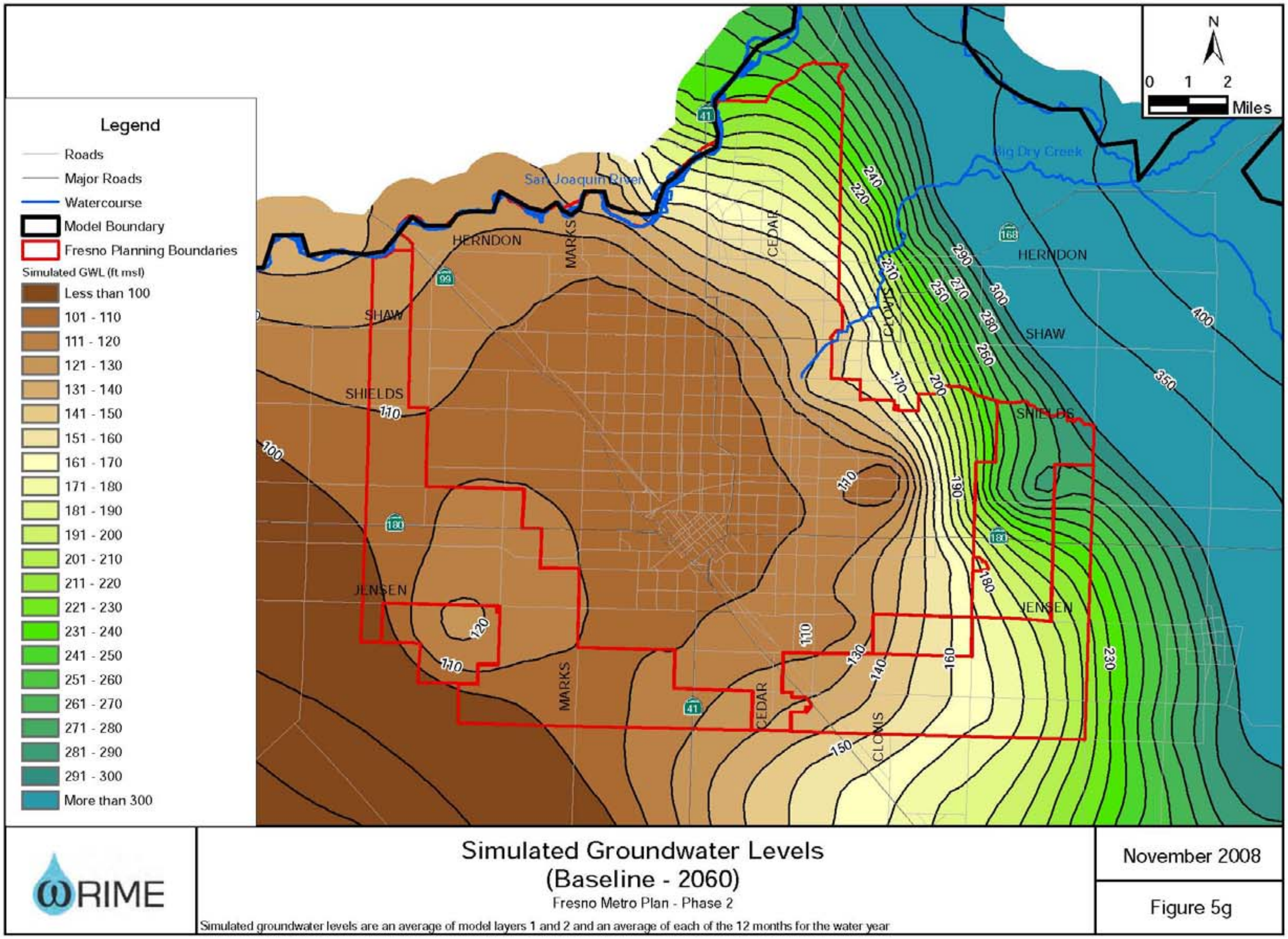

City of FRESNO

Figure 5-6. Baseline Condition: Simulated Groundwater Levels in 2060

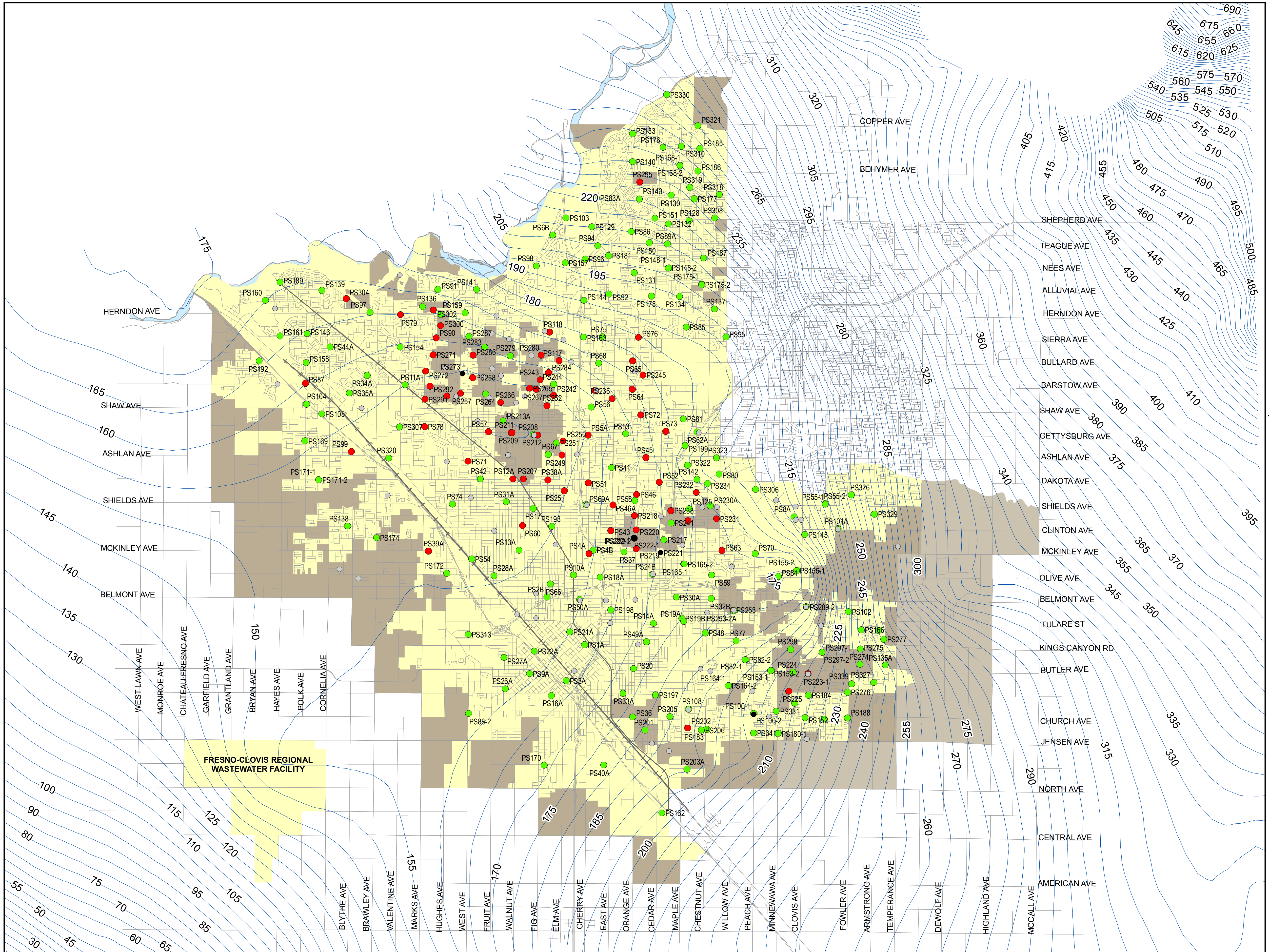

FIGURE 5-7

City of Fresno Metro Plan Update
Phase 2 Report
2025 GROUNDWATER ELEVATION WITHOUT PROPOSED PROJECT

0 1 2
Scale in Miles

Notes
1. "No Data" indicates no depth to pump bowl information available.
2. Groundwater contours provided by WRIME for projected 2025 groundwater elevations without proposed water supply project recommended in the Metro Plan.

LEGEND
- Groundwater elevation higher than pump bowl depth
- Groundwater elevation lower than pump bowl depth
- No Data
- Not in service
- Groundwater contours (No Project 2025)
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

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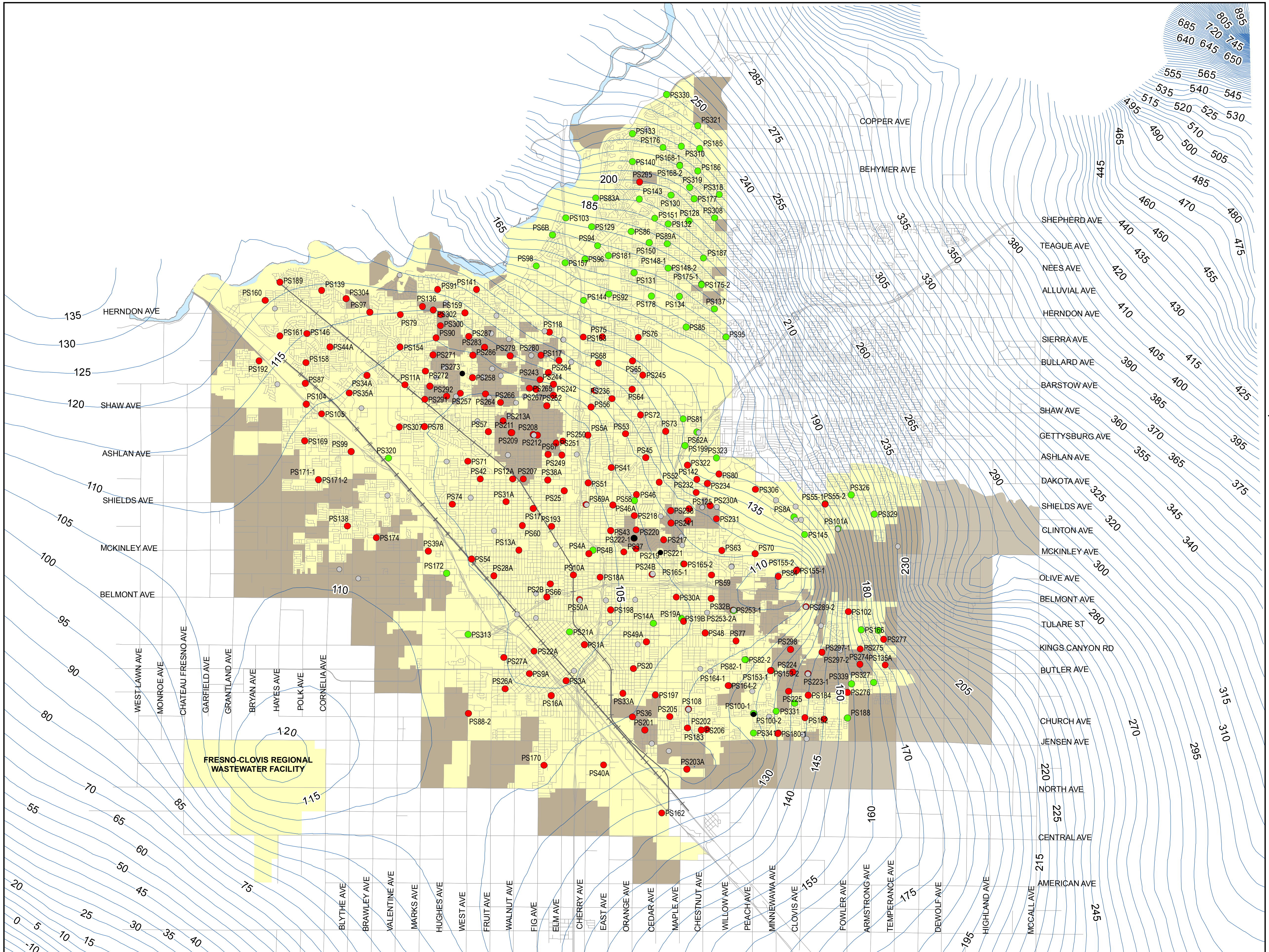

FIGURE 5-8

City of Fresno
Metro Plan Update
Phase 2 Report
2060 GROUNDWATER ELEVATION WITHOUT PROPOSED PROJECT

Scale in Miles: 0 1 2

Notes
1. "No Data" indicates no depth to pump bowl information available.
2. Groundwater contours provided by WRIME for projected 2060 groundwater elevations without proposed water supply project recommended in the Metro Plan.

LEGEND
- Groundwater elevation higher than pump bowl depth
- Groundwater elevation lower than pump bowl depth
- No Data
- Not in service
- Groundwater contours (No Project 2060)
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

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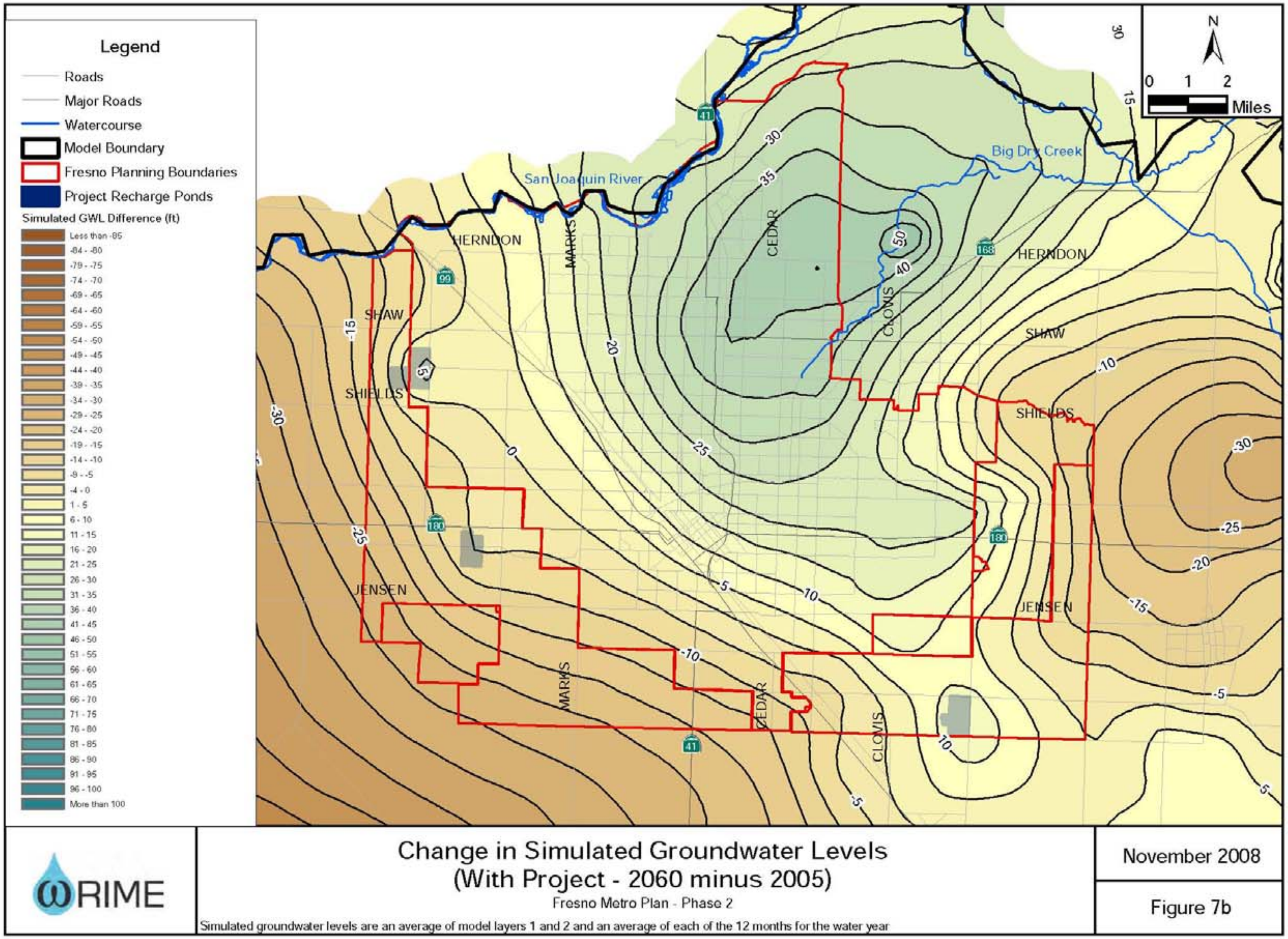


City of FRESNO

Figure 5-9. With Project Condition: Change in Simulated Groundwater Levels from 2005 to 2060

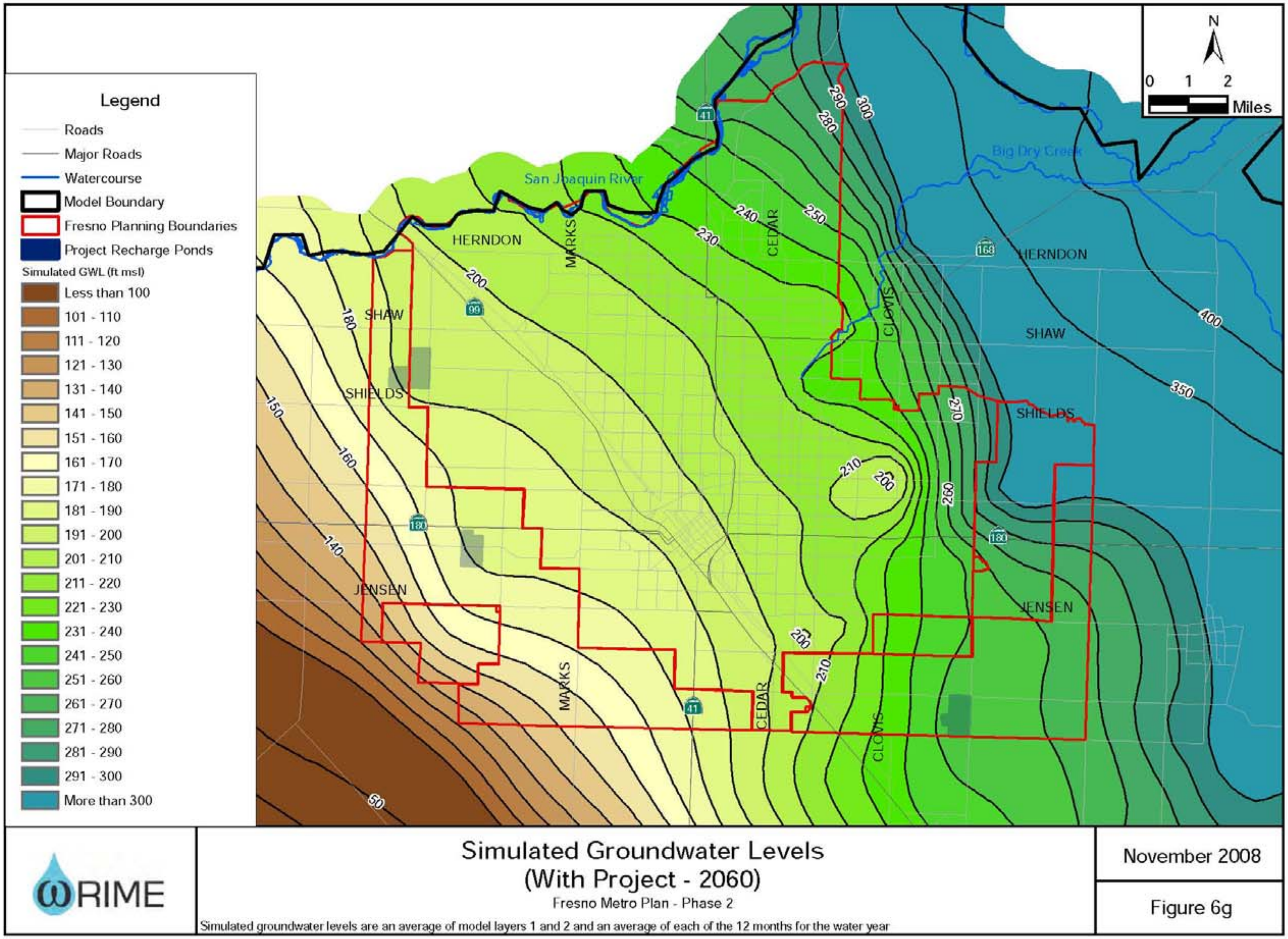


Figure 5-10. With Project Condition: Simulated Groundwater Levels in 2060

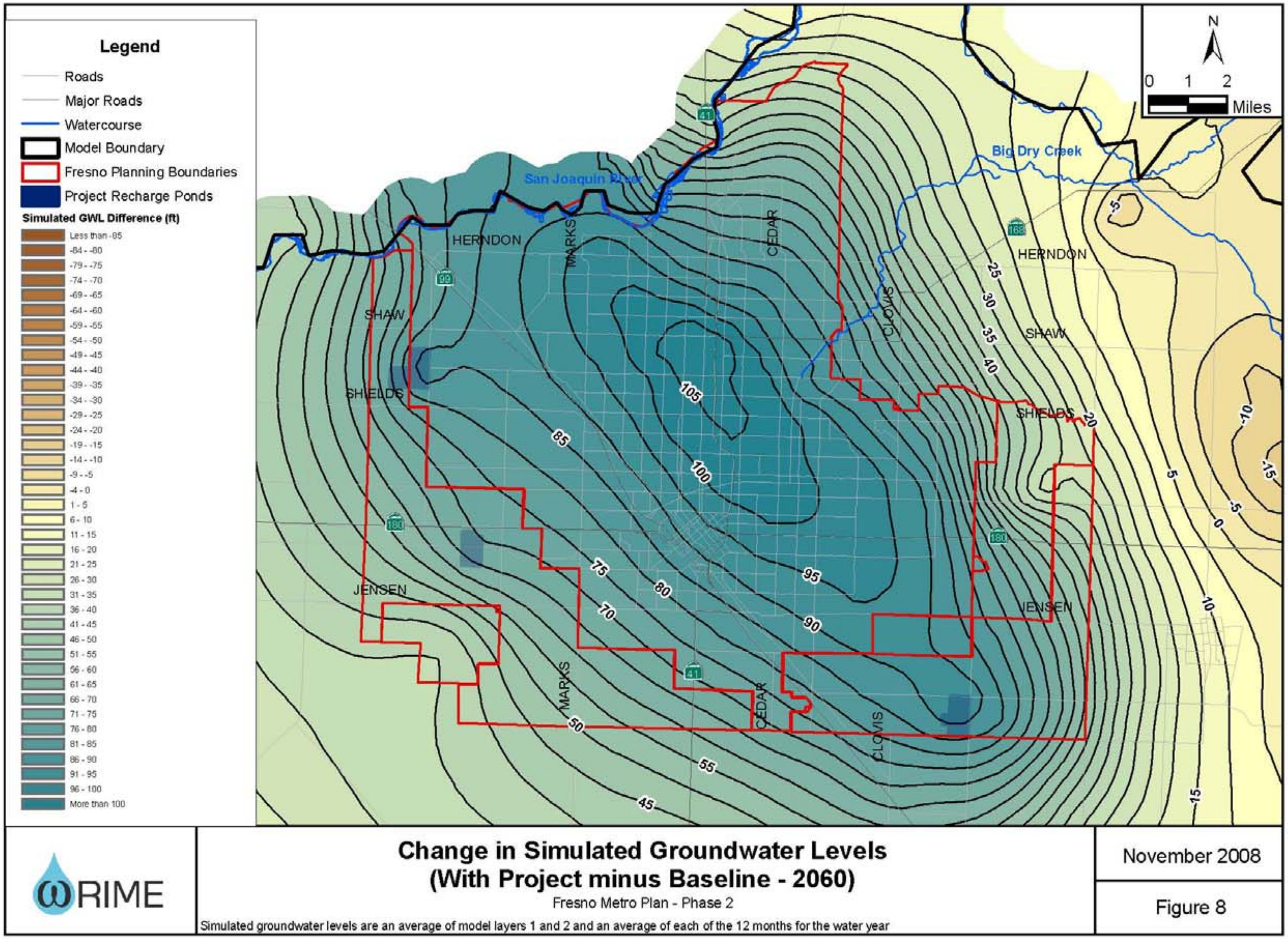
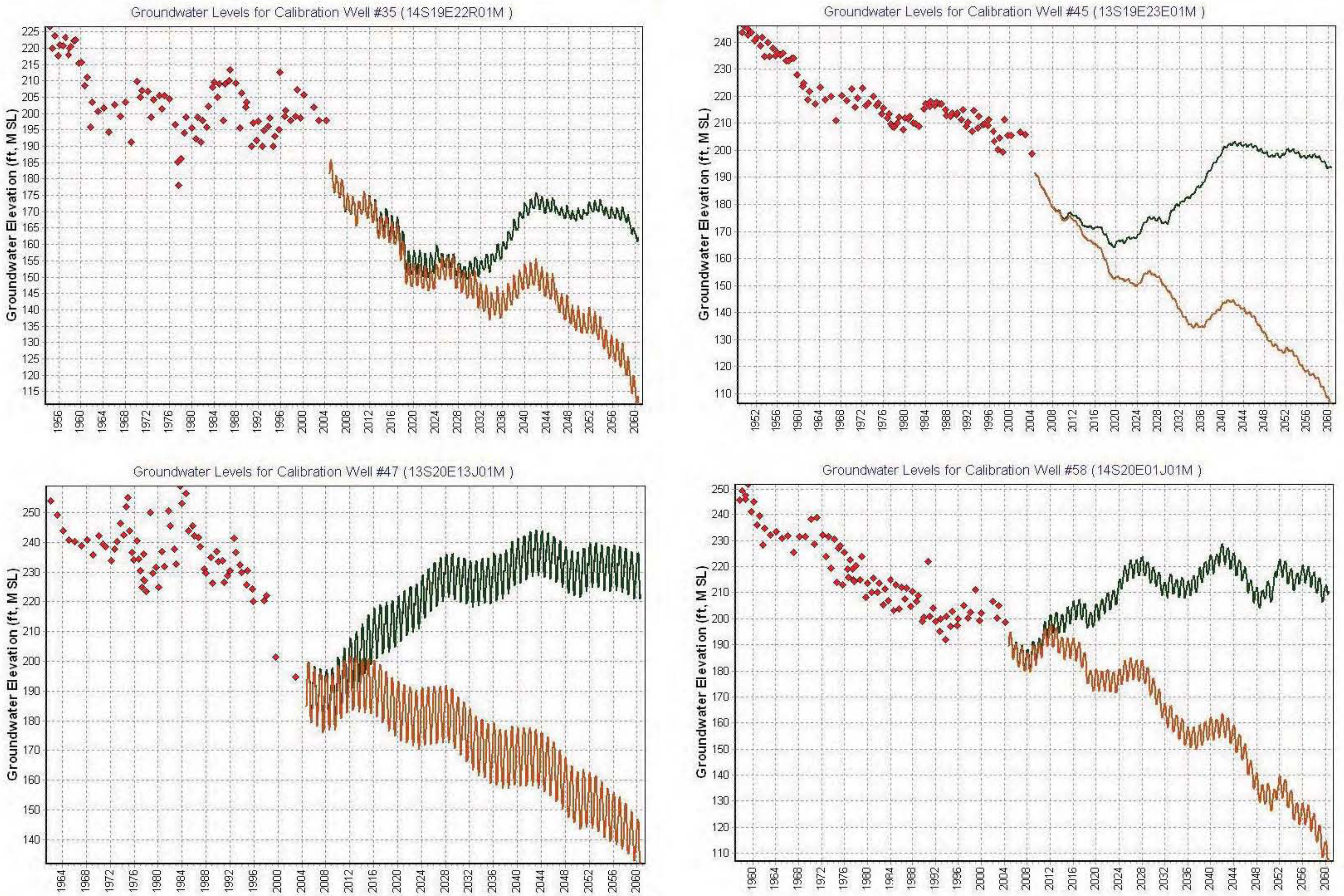
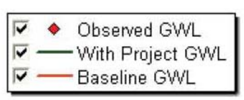


Figure 5-11. Change in Simulated Groundwater Levels in 2060 (With Project Condition – Baseline Condition)



See Appendix D Figure 9a for well locations



City of FRESNO

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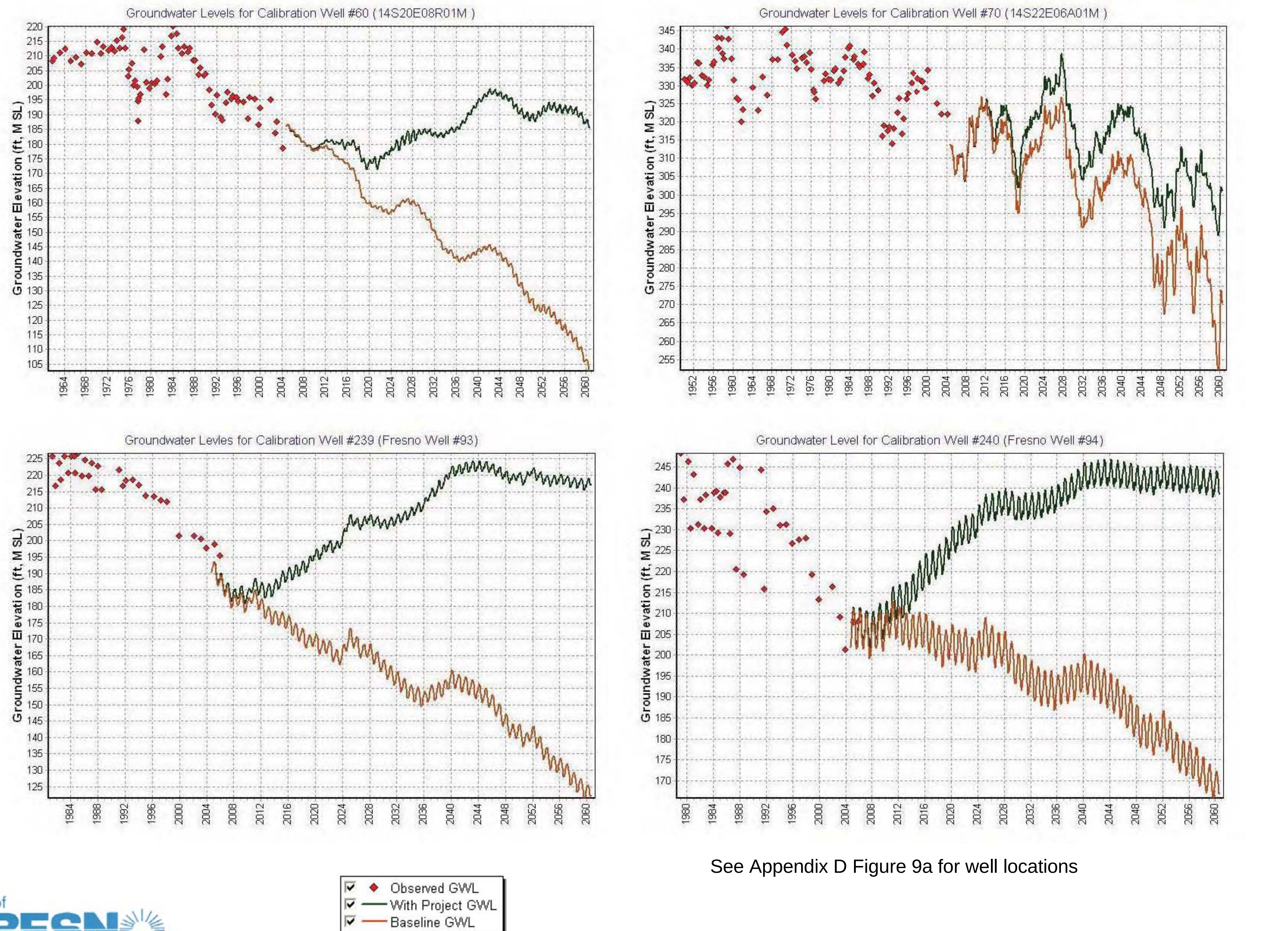
Figure 5-12a. Hydrographs for Key Wells in Fresno Sphere of Influence



See Appendix D Figure 9a for well locations

City of FRESNO

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Figure 5-12b. Hydrographs for Key Wells in Fresno Sphere of Influence

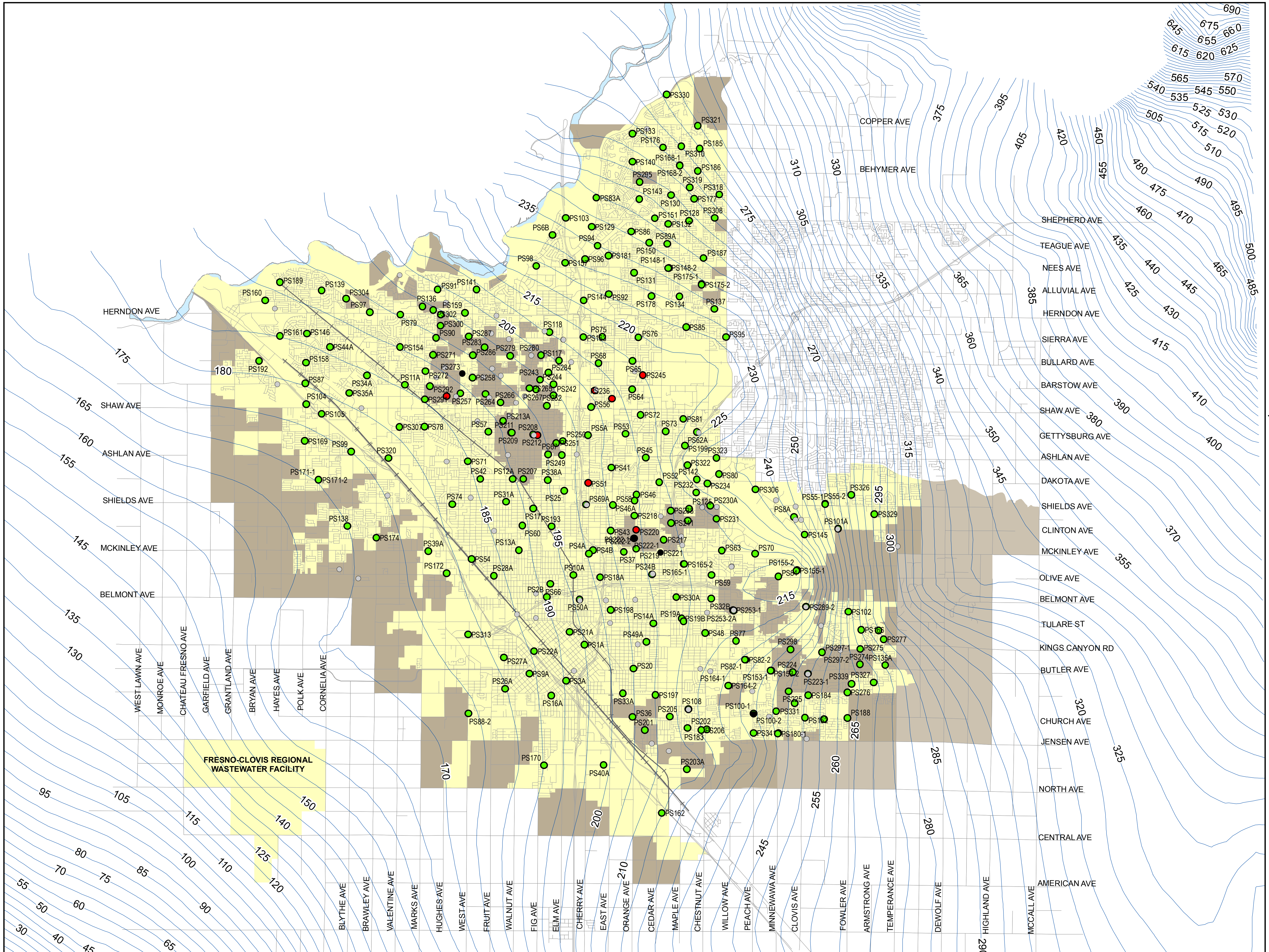

FIGURE 5-13

City of Fresno Metro Plan Update Phase 2 Report 2025 GROUNDWATER ELEVATION WITH PROPOSED PROJECT

Scale in Miles: 0 1 2

Notes

1. "No Data" indicates no depth to pump bowl information available.
2. Groundwater contours provided by WRIME for projected 2025 groundwater elevations with proposed water supply project recommended in the Metro Plan.

LEGEND

- Groundwater elevation higher than pump bowl depth
- Groundwater elevation lower than pump bowl depth
- No Data
- Not in service
- Groundwater contours (Project 2025)
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

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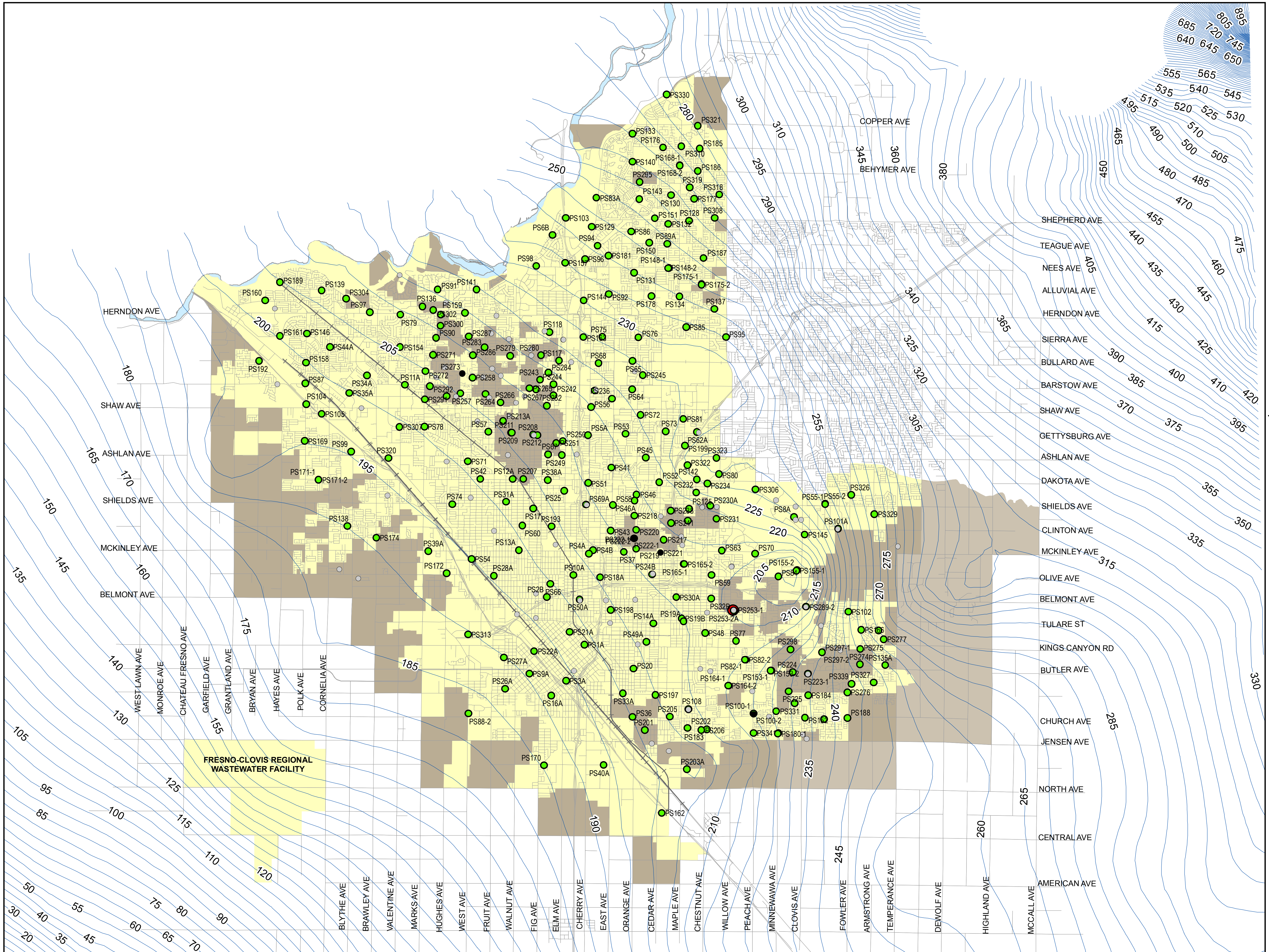
FIGURE 5-14

City of Fresno
Metro Plan Update
<u>Phase 2 Report</u>
2060 GROUNDWATER ELEVATION WITH PROPOSED PROJECT



0 1 2
Scale in Miles

Notes

1. "No Data" indicates no depth to pump bowl information available.
2. Groundwater contours provided by WRIME for projected 2060 groundwater elevations with proposed water supply project recommended in the Metro Plan.

LEGEND

- Groundwater elevation higher than pump bowl depth
- Groundwater elevation lower than pump bowl depth
- No Data
- Not in service
- Groundwater contours (Project 2060)
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

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CHAPTER 6. FUTURE SURFACE WATER

This chapter presents a description of the proposed future use of surface water as part of the City's overall future water supply plan. This chapter describes the City's existing use of available surface water supplies and the proposed expanded use in the future to maximize the use of the City's available surface water supplies, increase the City's conjunctive use of surface water and groundwater supplies and reduce groundwater pumpage to help stop groundwater level declines and restore groundwater levels to historical levels.

With the increased use of available surface water supplies, the City would need to pump more groundwater to meet increasing demands, and groundwater levels will continue to decline. This continued excessive use of groundwater could gain the attention of regulatory agencies and could initiate some form of regulation on groundwater pumpage. This potential "loss of control" of local water resources could be devastating to the City's ability to meet the future demands of its customers.

SURFACE WATER OBJECTIVES, GOALS, AND POLICIES

As described in Chapter 3, as part of the City's future water supply program, the City has proposed a number of specific objectives, goals, and policies. The specific objectives, goals, and policies related to surface water include the following:

Surface Water Objectives

- Increase conjunctive use of available supplies;
- Increase direct use of treated surface water; and
- Use of any additional, available surface water supplies for intentional groundwater recharge and/or groundwater banking to help achieve groundwater basin stabilization/replenishment.

Surface Water Goals

- Construct improvements to existing Northeast Surface Water Treatment Facility (SWTF) located in the northeast part of the City to achieve 30 mgd capacity as soon as possible;
- Construct a new 80 mgd (design capacity) Southeast SWTF in the southeast part of the City by 2015;
- Expand the existing Northeast SWTF by 30 mgd (to 60 mgd design capacity) by 2020; and
- Consider the future construction of a new Southwest SWTF (possibly 10 to 20 mgd).

Surface Water Policies

- Maximize use of available surface water supplies for direct potable use and intentional groundwater recharge;
- Construct dedicated recharge facility(s) to take full advantage of available surface water supplies, integrating concepts of regional and open space uses;
- Work cooperatively with FID to optimize water allocations to the City, including construction of infrastructure and conducting exchanges;
- Review and update the cooperative agreement with FID on an as-needed basis;
- Work cooperatively with FMFCD to improve recharge basin efficiency and increase the number of basins available for recharge;
- Further develop partnerships with FID, Clovis, and others to maximize available water resources;
- Provide additional staff and program-specific financial resources required to implement/manage surface water use program (e.g., water resource manager);
- Initiate active participation in Federal, State, regional, and local water planning and management organizations, activities, legislative activities, grant opportunities, etc; and,
- Monitor and pursue opportunities to acquire additional water supplies.

CURRENT SURFACE WATER USE

Current Surface Water Treatment and Direct Use

In late 2004, the City completed construction and began operation of its 30-mgd Surface Water Treatment Facility (SWTF) located in the northeastern part of the City. As shown in Table 6-1, production from the SWTF has been about 20,000 af/yr, and currently supplies about 12 percent of the City's total water demand. The SWTF currently has some operational constraints which prevent it from being operated at its full design capacity of 30 mgd; the current operational capacity is about 27.5 mgd. The City is working on improvements to allow for operation of the SWTF at its full design capacity.

Table 6-1. Historical Surface Water Treatment Facility Production

Year	Surface Water Treatment Facility Production, af/yr	Percent of Total Demand, %
2004[(a)]	4,060	2
2005	15,807	10
2006	19,701	13
2007	20,650	12
2008	20,116	12
2009	19,563	12

(a) Operation of the City's Northeast SWTF began in late 2004.

Current Intentional Groundwater Recharge

As described in the Phase 1 Report and in Chapter 5 of this Phase 2 Report, the City has an extensive intentional groundwater recharge program. Surface water supplies are routed into a number of recharge facilities located throughout the Fresno area. These facilities are owned and operated by a number of different agencies, including the City of Fresno, City of Clovis, FID, and FMFCD. From 2000 to 2009, intentional recharge averaged about 50,000 af/yr. In 2009, intentional recharge was about 54,600 acre-feet, somewhat higher than in recent years, due largely to an increase in intentional recharge at the FMFCD basins. As described in Chapter 5, intentional recharge at the City's Leaky Acres facility was only 5,136 af in 2008, the lowest annual recharge ever at that facility. In 2009, recharge at Leaky Acres increased to 9,517 af. As discussed in Chapter 5, this annual intentional recharge is far less than the annual quantity of groundwater being pumped by the City, resulting in "unbalanced" groundwater operations.

FUTURE SURFACE WATER USE

As described in the Phase 1 Report, the availability of surface water supplies from FID increases as the City annexes FID lands within the City's SOI and varies annually based on hydrologic conditions. Table 6-2 provides a summary of the estimated future surface water supply availability from FID, USBR and exchange water under various hydrologic conditions. These are graphically shown on Figure 6-1.

Table 6-2. Surface Water Supply Available to the City under Various Hydrologic Conditions[a]

Hydrologic Year Classification	Surface Water Supply Available to the City[b], af/yr			
	2010	2015	2020	2025
Wet	187,600	200,200	212,900	225,600
Normal-wet	177,500	189,000	200,600	212,200
Normal	166,800	177,400	187,900	198,500
Normal-dry	156,800	166,500	176,200	185,800
Dry	130,900	139,600	148,300	157,600
Critical-high	95,500	101,800	108,100	114,400
Critical-low	76,900	82,300	87,800	93,300

(a) Source: Tables 5-8, 5-11, and 5-12, Chapter 5, Metro Plan Update Phase 1 Report, December 2007.
(b) Includes FID Kings River, USBR Class 1, and recharge exchange water.

One of the City's policies for surface water is to maximize the use of available surface water supplies, either through treatment and direct use or intentional groundwater recharge, such that each year, all available surface water supplies, to the extent possible, are put to beneficial use. This can be achieved by expanding the City's surface water treatment capacity in combination with expanding the City's groundwater recharge capacity, and possibly implementing a future groundwater banking program. Each of these is described below.

Future Surface Water Treatment and Direct Use

<u>Future Surface Water Treatment Capacity</u>

As described in Chapter 3, the City's future water supply plan calls for an average total future surface water treatment capacity of 120 mgd. Based on the City's current SWTF operations (e.g., 11 months per year, with the SWTF shut down 1 month per year for canal maintenance or other SWTF maintenance), an average total treatment capacity of 120 mgd will allow for the City to treat up to 123,400 af/yr of surface water supplies for direct use. Based on the projected water demand for the year 2025, this would equate to about 53 percent of the City's projected demand of 234,400 af/yr.

As shown on Figure 6-2, the proposed surface water to be treated for direct use roughly corresponds to the City's future projected availability of surface water supplies in hydrologic conditions between critical high dry year and dry year conditions. This means that in critical high dry years, there may not be adequate surface water supplies available, and surface water production from the SWTFs may be somewhat restricted. However, in dry year conditions (and all other "wetter" conditions), there will be adequate surface water supplies available to operate the proposed SWTFs at full capacity. In these "wetter" conditions, (e.g., non-critically dry years), when more surface water supplies are available, the available surface water supplies which are not treated for direct use should be used to the maximum extent possible for intentional groundwater recharge and/or future groundwater banking purposes (see additional discussion later in this chapter and in Chapter 8 of this Phase 2 Report).

Expansion of the City's surface water treatment capacity is proposed as follows:

1. Completion of operational improvements to the existing Northeast SWTF to allow for maximized production based on the original design capacity of 30 mgd (these improvements should be completed as soon as possible);
2. Construction of a new 80 mgd Southeast SWTF (design capacity) (70 mgd average capacity for 11 months of the year) in the southeast part of the City (by 2015); and
3. Future expansion of the existing Northeast SWTF to 60 mgd (design capacity) (50 mgd average capacity for 11 months of the year) (by 2020).

The proposed schedule for the construction of the new Southeast SWTF and the expansion of the Northeast SWTF is predicated on the City's goal to balance groundwater operations by 2025 (see Chapter 5). A delay in constructing the additional surface water treatment capacity will delay the City's ability to balance groundwater operations. Furthermore, phased construction of the proposed facilities will result in higher costs and potential further delays in the City's ability to balance groundwater operations.

Each of the proposed water treatment capacity improvements is described in more detail below.

Operational Improvements for Existing Northeast SWTF

As described above, the City's existing SWTF currently has some operational constraints which prevent it from being operated at its full design capacity of 30 mgd. The current operational capacity is about 27.5 mgd. The City is working on improvements to allow for the operation of the SWTF at its full design capacity. At a design capacity of 30 mgd, the City would have the ability to treat up to 30,800 af/yr of surface water supplies for direct use. These improvements should be completed as quickly as possible to take full advantage of the existing constructed facilities and maximize production from the existing SWTF.

New 80 mgd Southeast SWTF

A new SWTF is proposed in the southeastern part of the City to increase the City's overall surface water treatment capacity and to help meet projected demand in the City's proposed Southeast Growth Area and adjacent existing neighborhoods. As described in Chapter 5, due to hydrogeologic conditions in the southeastern part of the City, the potential for groundwater recharge operations in the southeastern part of the City is poor. Also, the presence of TCP in a number of the City's wells may result in a loss in groundwater production capacity in the southeastern part of the City. Therefore, the use of treated surface water to meet demands in the southeastern part of the City will help to meet demands and minimize impacts to the groundwater basin in this part of the City. Treated surface water supplies from the new Southeast SWTF will serve existing customers, the 501S Growth Area, and the Southeast Growth Area.

The proposed 80 mgd design capacity Southeast SWTF will allow the City to treat up to 72,000 af/yr of surface water supplies for direct use (based on an average treatment capacity of 70 mgd for 11 months of the year). Based on the proposed location of the new Southeast SWTF, the source of the raw water supply for the new Southeast SWTF would be from FID's Mill Ditch. Based on the City's future water supply plan, the new Southeast SWTF should be completed and operational by no later than 2015.

A Siting Study for the new SWTF was conducted in late 2006 as part of this Metro Plan Update (see Appendix A). The Siting Study evaluated four alternative sites for a new SWTF, including expansion of the existing SWTF, as well as three other new sites located in various parts of the City (one site near the City's existing Leaky Acres recharge facility and two sites in the southeastern part of the City). Based on the evaluation, it was recommended that a new site in the southeastern part of the City should be pursued for a future SWTF (specifically a 23-acre site located at the southeast corner of Clovis Avenue and McKinley Avenue).

However, since the completion of the siting study, the specific property that was recommended became unavailable for use as a future SWTF site. However, in 2009, the City purchased a 58-acre property at the northwest corner of Armstrong and Olive Avenues for the proposed new Southeast SWTF; this property is in the same general vicinity as the site previously recommended. Also since the completion of the SWTF Siting Study, as described above, it has been determined that the new SWTF should have a design treatment capacity of 80 mgd, instead of 30 mgd, to provide the City with additional surface water treatment capacity and operational flexibility, and help meet projected future demands in the southeastern part of the City.

Expansion of the Existing Northeast SWTF

In addition to the construction of a new Southeast SWTF, it is proposed that the City's existing SWTF located in the northeastern part of the City be expanded by 30 mgd to a total design capacity of 60 mgd by the year 2020. This proposed expansion would provide the City with the capability to treat a total of 51,400 af/yr for direct use from the Northeast SWTF (based on an average treatment capacity of 50 mgd for 11 months of the year)) and would help to mitigate groundwater overdraft conditions in the northeastern part of the City.

As discussed in the SWTF Siting Study (see Appendix A), the existing Northeast SWTF site has adequate space to expand the existing treatment capacity by up to an additional 30 mgd (up to a total design capacity of 60 mgd), and the existing raw water supply facilities which currently deliver supply to the site were originally designed to handle the anticipated future 60 mgd flow. The source of the raw water supply for the existing Northeast SWTF is currently FID's Enterprise Canal. The City has plans to construct a pipeline from the Friant-Kern Canal to the Northeast SWTF (a distance of approximately 5 miles) to provide raw water quality enhancements, increase public health protection, and develop adequate hydraulic head to operate the SWTF by gravity feed. After this pipeline is constructed, use of the Enterprise Canal will be considered as a secondary raw water supply source to the Northeast SWTF.

Potential Future Southwest SWTF

In the future, the City may also wish to consider the construction of an additional SWTF with a treatment capacity of 10 to 20 mgd in the southwestern part of the City. This would provide added flexibility for serving future demands in the southwestern portion of the City. A general location for a future Southwest SWTF is shown near South Marks Avenue and West California Avenue along the Dry Creek Canal on Figure 9-1 in Chapter 9. Alternative locations along the

Dry Creek Canal may also be evaluated. The exact location for a future Southwest SWTF will be determined in the future.

Table 6-3 provides a summary of the proposed future surface water treatment capacities.

Table 6-3. Proposed Future Surface Water Treatment Capacity

Surface Water Treatment Facility	Design Capacity (Average Treatment Capacity)[a], mgd	Annual Production Capacity, af/yr
Existing Northeast SWTF		
Current Operational Capacity	27.5 mgd	28,300 af/yr
Design Capacity	30 mgd	30,800 af/yr
Future Expansion (Additional 30 mgd) (by 2020)	60 mgd (50 mgd)	51,400 af/yr
New Southeast SWTF (by 2015)	80 mgd (70 mgd)	72,000 af/yr
Potential Future Southwest SWTF (timing to be determined)	10 to 20 mgd	To be determined
Total Nominal Future SWTF Treatment and Production Capacity[b]	140 mgd (120 mgd)	123,400 af/yr

(a) Average treatment capacity is based on an 11-month operations period each year to produce the required quantity of treated surface water for direct use.

(b) Does not include potential new Southwest SWTF, for which the timing and treatment capacity will be determined in the future.

Source Water Conveyance and Water Quality

The City's existing Northeast SWTF obtains its source water via the Enterprise Canal. The proposed new Southeast SWTF would likely obtain its source water from the Mill Ditch. The Enterprise Canal and Mill Ditch are both open channels owned and operated by FID, supplied by similar source waters. However, the delivered water quality is probably slightly better from the Mill Ditch during the irrigation season, because the Mill Ditch has higher flow rates with higher velocities. Because of the higher velocities, weed growth is much less in Mill Ditch, which results in less frequent treatment with aquatic herbicides.

As discussed above, the City plans to construct a 5-mile-long pipeline from the Friant-Kern Canal to the existing Northeast SWTF, so that, in the future, source water is no longer conveyed to the Northeast SWTF via the open Enterprise Canal.

Carollo Engineers conducted an evaluation of raw water quality for both the expansion of the Northeast SWTF and the new Southeast SWTF. Based on limited water quality data, the source water appears to be of a high quality. However, additional water quality sampling should be performed as part of the planning and design of the new and expanded treatment facilities. A copy of Carollo Engineers Technical Memorandum 2-4 describing water quality and treatment issues related to surface water is provided in Appendix B of this Phase 2 Report. Recommended treatment processes are described below.

Recommended Treatment Processes

Northeast SWTF

The Northeast SWTF currently uses a modified conventional treatment plant process to treat its Enterprise Canal source water. The treatment processes at the City's existing Northeast SWTF include coagulation, flocculation, high-rate ballasted sedimentation, intermediate ozonation, and granular activated carbon (GAC) filtration, followed by a small finished water reservoir. Chlorine is added as a secondary disinfectant. Based on the raw water quality in the Friant-Kern Canal, the current processes can be successfully applied to the new supply source. One unknown is the required level of *Cryptosporidium* removal/inactivation that will be required based on the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2 ESWTR) source water sampling. For this reason, the ozonation system should be designed at the conceptual level to achieve *Cryptosporidium* disinfection as well as address other goals such as taste and odor reduction and organics reduction.

Southeast SWTF

Process selection for the new Southeast SWTF is based on the raw water quality and finished water quality goals described in Carollo Engineers' Technical Memorandum 2-4 describing water quality and treatment issues related to surface water (see Appendix B). Based on the raw water data and finished water goals, a conventional treatment facility consisting of coagulation, flocculation, sedimentation, and filtration using GAC media is an appropriate design basis. The addition of a treatment process to provide control of taste and odor causing compounds and provide potential additional disinfection of *Cryptosporidium* should also be considered.

The existing Northeast SWTF consists of a modified conventional treatment process with intermediate ozonation and GAC media for filtration and adsorption. To reduce plant footprint, instead of traditional sedimentation basins, the Actiflo® process was provided. This process can be successfully applied to the new Southeast SWTF and meet all of the identified finished water quality goals. One unknown is the required level of *Cryptosporidium* removal/inactivation that will be required based on the LT2 ESWTR source water sampling. For this reason, the ozonation system should be designed at the conceptual level to achieve *Cryptosporidium* disinfection, as well as address other goals such as taste and odor reduction and organics reduction.

Future Intentional Groundwater Recharge

As described above, the City's intentional groundwater recharge has decreased in recent years due to operational constraints at several of the recharge facilities. This decreased recharge, in conjunction with increased groundwater pumpage to meet increasing demands, has resulted in unbalanced groundwater operations by the City. As described in Chapter 5, one of the City's goals is to balance its groundwater operations, whereby groundwater recharge equals groundwater pumpage. As described in Chapter 5, this will require on-going maintenance of existing recharge facilities, as well as the construction of new recharge facilities. Once these facilities are available, any available surface water supplies beyond what is treated for direct use should be used for groundwater recharge. As noted above, in critically dry years, there may be little available surplus surface water beyond those supplies which are treated for direct use. However, as shown on Figure 6-2, in wet, normal, and even dry years, there should be surplus supplies available for groundwater recharge. These surplus available supplies should be put to beneficial use to their maximum extent.

Future Groundwater Banking

Also, in the future, the City should consider the use of surplus surface water supplies for a groundwater banking program to allow for storage of supplies available in wet years for later use in dry years. This potential future program is discussed further in Chapter 8 of this Phase 2 Report.

REQUIRED INFRASTRUCTURE AND COSTS

Additional discussion regarding the required infrastructure, and associated costs, to support this future surface water supply is provided in Chapter 9 of this Phase 2 Report.

Figure 6-1. City of Fresno Surface Water Available Under Various Hydrologic Conditions

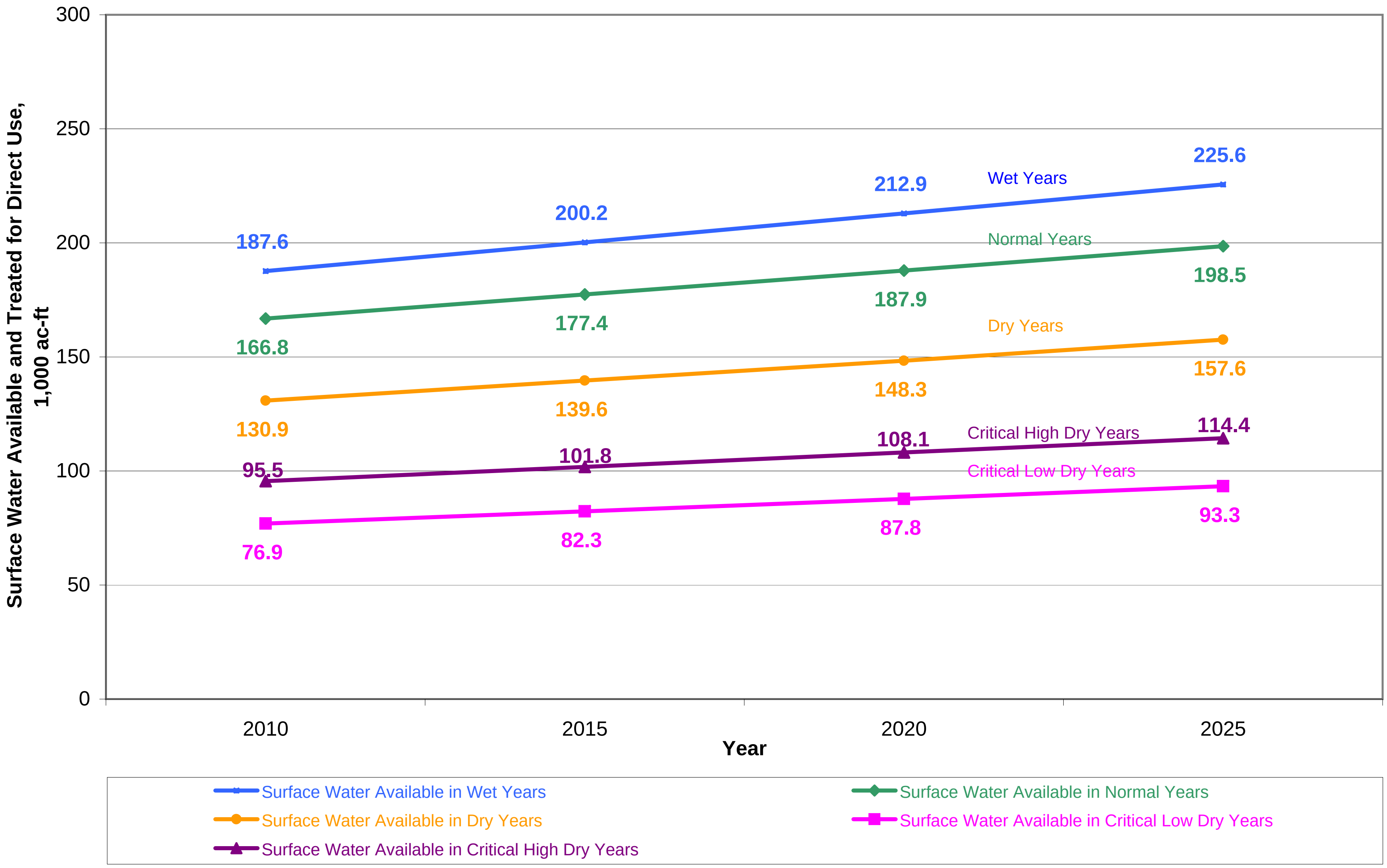
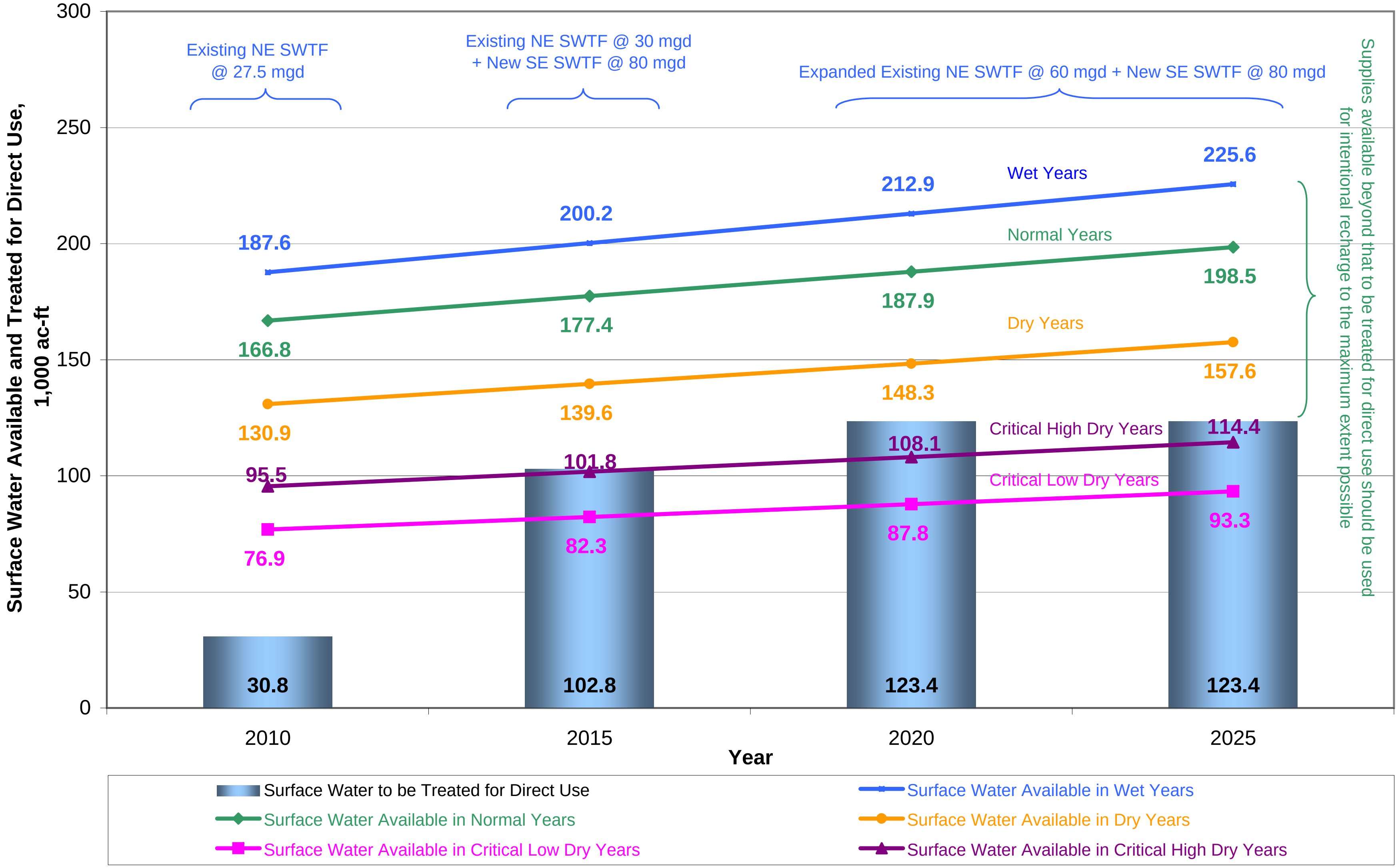


Figure 6-2. City of Fresno Surface Water to be Treated for Direct Use



CHAPTER 7. FUTURE RECYCLED WATER

This chapter presents a description of the City's anticipated future use of recycled water, as part of its overall future water supply plan. Recycled water will be an important component of the City's future water supply portfolio, as it provides an opportunity to reduce the use of potable water supplies to meet non-potable demands, such as landscape irrigation. As described in this chapter, opportunities for recycled water use are anticipated in the City's future development areas and within existing areas of the City (e.g., for existing parks and other large landscaped areas).

Carollo Engineers has prepared a brief technical memorandum summarizing the City's current water recycling activities and how the City plans to expand recycled water use in the future as part of its overall future water supply plan. A copy of their technical memorandum (TM 2-2 dated April 28, 2008) is provided in Appendix B of this Phase 2 Report.

A detailed Recycled Water Master Plan is also being prepared in parallel with this Metro Plan Update to identify potential recycled water uses, general use locations, and project the future recycled water demand. It will also establish the regulatory requirements, infrastructure needs, timing, and capital improvement program. A brief description of the topics to be evaluated in the Recycled Water Master Plan is provided at the end of this chapter.

FUTURE RECYCLED WATER OBJECTIVES, GOALS, AND POLICIES

As described in Chapter 3, as part of the City's future water supply program, the City has proposed a number of specific objectives, goals, and policies. The specific objectives, goals, and policies related to recycled water include the following:

Recycled Water Objectives

- Increase the use of recycled water to help offset existing/future potable water demands; and
- Maximize the use of available recycled water recharge exchange supply from the FID Agreement.

Recycled Water Goals

- Provide 25,000 af/yr of recycled water by 2025 for landscape irrigation and other non-potable water uses to offset potable water demands.

Recycled Water Policies

- Require new developments City-wide to install "purple pipe" for recycled water use on parks, common areas, roadway medians, etc.;
- Look for opportunities to install purple pipe near existing landscaped areas (e.g., parks, sports fields) (i.e., "piggyback" on other pipeline installation/replacement projects);

- Work with FID and/or others to develop an agreement to better use the percolated treated effluent from the wastewater treatment plant;
- Further develop partnerships with FID, Clovis, and others to maximize available water resources;
- Allow new development to create “new” supplies by participation in the implementation of recycled water facilities and projects;
- Adopt and implement the Recycled Water Master Plan; and
- Provide additional staff and program-specific financial resources required to implement, manage and maintain the recycled water use program.

CURRENT RECYCLED WATER USE

Regional Wastewater Reclamation Facility

As described in the Phase 1 Report, the Fresno-Clovis Regional Wastewater Reclamation Facility (RWRF) has a treatment capacity of approximately 80 mgd (annual monthly average daily discharge flow). It provides secondary wastewater treatment with effluent disposal to a combination of percolation ponds and irrigation reuse (no effluent from the RWRF is discharged to surface water). The facility consists of a headworks followed by primary settling and the secondary activated sludge biological treatment processes. The facility has the capability of incorporating the old trickling filter plant into the process to augment the activated sludge process.

Secondary effluent from the RWRF is discharged into a canal system feeding a series of percolation ponds, and local farmers utilize a portion of the effluent (about 10 percent) for direct reuse on agricultural land. In 2007, the RWRF discharged 10,935 af to neighboring farmland for irrigation of feed/fodder and fiber crops, and 27,000 af to the FID canals, for a total of about 37,000 af[1]. The City also reclaims a portion of this previously percolated effluent by extracting groundwater and delivering it to FID for FID’s conveyance and use downstream of the RWRF. The City’s agreement with FID stipulates that, in exchange for this previously percolated effluent, FID will provide the City with a certain percentage of surface water supplies. The agreement also states that the City will retain its effluent within the FID boundaries unless approval from FID is obtained. The potential for future modification of this existing wastewater recycled exchange agreement is discussed in Chapter 8 of this Phase 2 Report.

The RWRF currently provides only secondary treatment, and does not produce a wastewater effluent that is suitable for Title 22 unrestricted use for landscape irrigation (i.e., tertiary treatment). In the future, if wastewater is to be treated to a tertiary level at the RWRF, additional filtration, nitrogen removal and disinfection facilities would need to be constructed at the RWRF.

[1] Source: Carollo Engineers, TM 2-2 for Fresno Metro Plan, April 28, 2008.

North Fresno Wastewater Reclamation Facility (WRF) Satellite Plant

The North Fresno Wastewater Reclamation Facility (WRF) was recently built to serve the Copper River Ranch development and golf course in the northern part of Fresno. The permitted capacity of the plant is 0.71 mgd (average monthly flow) and 1.08 mgd (maximum daily flow). The plant is master planned for expansion to 1.25 mgd (average monthly flow) at buildout.

Disinfected tertiary recycled water from the North Fresno WRF will be used to irrigate the Copper River Ranch Golf Course. The golf course is within the City Limits of Fresno. Until now, the golf course has been irrigated almost exclusively with surface water provided by FID, and supplemented with a minimal amount from an agricultural well.

During wet weather months, recycled water in excess of turf demands will be dechlorinated and sent to a nearby percolation basin owned by FMFCD, and used to irrigate landscaped areas within the basin. Projected recycled water use for the North Fresno WRF ranges from about 750 af/yr to about 1,250 af/yr at buildout.

FUTURE RECYCLED WATER USE

Future Recycled Water Use Areas

New Development Areas

In previous evaluations (e.g., the 1996 RWRF Master Plan), it was concluded that landscape irrigation with treated effluent from the RWRF was economically infeasible and impractical to implement. The high costs to treat and distribute the recycled water could not be justified, due to a limited customer base, seasonal usage, and scattered locations throughout the City.

However, the City's 2025 General Plan includes significant new development areas (e.g., the North Growth Area and the Southeast Growth Area). The Southeast Growth Area at buildout of the 2025 General Plan includes about 8,700 acres of new development. Alternative land use plans for the SEGA Project are being evaluated, and include a relatively large amount of landscaped area (i.e., parks, sports fields, school yards, golf courses, roadway medians and shoulders). If it is assumed that these landscaped areas will be irrigated with recycled water, it is estimated that the total recycled water demand within the Southeast Growth Area would be about 5,100 af/yr. This is about 18 percent of the total projected 2025 water demand for the Southeast Growth Area Preferred Land Use Alternative (27,800 af/yr)[2]. Without the availability of recycled water, these irrigation demands would need to be met using potable water supplies.

These new development areas provide the ideal opportunity to incorporate recycled water use for landscape irrigation and other non-potable water use into the City's future water supply portfolio. Ideally, all landscaped areas within these new development areas (e.g., parks, sports fields, golf courses, common areas, and roadway medians) should be supplied with recycled water. Recycled

[2] Technical Memorandum "Projected Potable and Non-Potable Water Demands, Wastewater Flows and Conceptual Water Supply Plan at Buildout of the Southeast Growth Area (SEGA) Project", prepared by West Yost Associates, prepared for EDAW AECOM, dated February 12, 2010.

water should also be considered for other non-potable water uses, such as cooling systems and other industrial uses. A separate recycled water "purple pipe" transmission and distribution system should be planned, designed and constructed upfront in conjunction with other utility systems to allow for delivery of recycled water supplies to these new development areas, and "purple pipe" irrigation systems should be installed within these new development areas. The installation of such "purple pipe" distribution and irrigation systems should be established as a condition of approval for all new development areas.

<u>Existing Landscaped Areas and Other Non-Potable Water Uses</u>

In addition, as these new development areas develop, the City should look for opportunities to convert existing large landscaped areas (e.g., parks, cemeteries, sports fields, roadway medians) and other non-potable water use (i.e., cooling systems, industrial uses, car washes, etc.) along the transmission/distribution utility corridors serving these new development areas. The possible extension of this non-potable water distribution system within the City core should also be evaluated.

As part of the development of the Recycled Water Master Plan, an estimate of future recycled water use within the City has been developed. This estimate of future recycled water use is 8,000 to 9,000 ac/yr, not including the SEGA project area.

The process distributing and delivering recycled water supplies within existing developed areas to numerous locations can be costly and disruptive as it requires existing infrastructure (including roadways, distribution systems, irrigation systems, and other facilities) to be upgraded or replaced. However, whenever possible, the City should look for opportunities to "piggyback" on other utility improvement projects (e.g., installing recycled water pipelines at the same time (with the appropriate vertical and horizontal clearances) as other water pipeline installations or replacement projects), to minimize the recycled water system implementation costs and disruption to existing neighborhoods.

To implement and/or fund these types of existing facility/system improvements, the City may also wish to consider allowing "exchange agreements" with developers, whereby a developer is allowed to proceed with a project and receive a potable water supply allotment, in exchange for providing the infrastructure (or funding for the infrastructure) needed to convert a like amount of potable water demand to recycled water demand on existing City non-potable water use areas.

<u>Use of Recycled Water Supplies by Other Agencies</u>

As part of this Metro Plan Update, several other recycled water agencies in California were surveyed to collect information on current use of and/or marketing strategies for recycled water in California. The agencies contacted included the City of Santa Rosa, the Town of Windsor, the Monterey Regional Water Pollution Control Authority, the Orange County Water District, and the Inland Empire Utilities Agency.

Recycled water uses by these agencies are summarized in Table 7-1.

Table 7-1. Recycled Water Use by Surveyed Recycled Water Agencies

Recycled Water Use	City of Santa Rosa	Town of Windsor	Monterey Regional Water Pollution Control Authority	Orange County Water District	Inland Empire Utilities Agency
Landscape Irrigation	✓	✓		✓	✓
Agricultural Irrigation	✓	✓	✓		✓
Industrial				✓	✓
Groundwater Recharge				✓	✓
Seawater Barrier				✓	
Other	✓ Geysers Recharge Project	✓ Geysers Recharge Project			✓ Wetlands Restoration

One of the main objectives of the survey was to obtain advice and knowledge from the experiences of these other recycled water agencies in California. Some of the key points made by the surveyed agencies included the following:

- Work closely and understand the seasonal irrigation needs of agricultural customers;
- Work closely with stakeholders;
- Work closely with the local public health department to establish rules and regulations early on in the process;
- Develop a strong public outreach program with support from a local medical group or association willing to make public statements in support of recycled water use to respond to customer health and safety concerns;
- Establish a funding and financing strategy and plan early in the process; and
- Join the WateReuse Foundation to provide networking opportunities with other recycled water agencies and obtain assistance with public outreach activities.

A technical memorandum discussing the findings of the survey is provided in Appendix F of this Phase 2 Report. A more detailed evaluation of the potential recycled water uses and marketing of recycled water will be conducted as part of the proposed Recycled Water Master Plan (see additional discussion below).

Projected Future Recycled Water Demand

Based on the assumptions described above, a preliminary estimate for future recycled water demand has been made. Table 7-2 presents a preliminary estimate of recycled water demand within the City's 2025 General Plan area.

Table 7-2. Preliminary Estimate of Future Potential Recycled Water Demand

Use Area	Total Recycled Water Demand, af/yr
General Plan Area	
North Fresno (Copper River Ranch Golf Course)	750 af/yr (initially) 1,250 af/yr (buildout)
Southeast Growth Area	5,100 af/yr [(a)]
Existing City Areas	8,000 to 9,000[(b)]
Miscellaneous Uses	10,000 af/yr[(c)]
Potential Recycled Water Demand within City's 2025 General Plan Area	**25,000 af/yr**

(a) Based on proposed land uses in the Preferred Land Use Alternative as evaluated in the Technical Memorandum "Projected Potable and Non-Potable Water Demands, Wastewater Flows and Conceptual Water Supply Plan at Buildout of the Southeast Growth Area (SEGA) Project", prepared by West Yost Associates, prepared for EDAW AECOM, dated February 12, 2010.
(b) Based on the demand estimates prepared by Carollo Engineeers for the Recycled Water Master Plan.
(c) Specific locations and uses to be determined.

This estimated future recycled water demand is based on preliminary estimates of future landscape irrigation and other non-potable water uses for direct use as a potable water demand offset. This demand estimate will need to be refined as part of the Recycled Water Master Plan (see below).

If 25,000 af/yr of recycled water use to offset potable water demands is not achieved by 2025, the City may need to pump more groundwater to meet potable water demands in the period before the 25,000 af/yr offset is achieved. This impact would impact the City's ability to achieve and maintain balanced groundwater operations. Other options for recycled water use being explored in the Recycled Water Master Plan include groundwater recharge using recycled water, exchange agreements to exchange recycled water for other water supplies, and retrofitting of other existing parts of the City for increased recycled water use within the City.

The incorporation of recycled water into the City's water supply portfolio will likely be an incremental process with recycled water service being provided to new development and existing areas as development occurs and as opportunities arise.

Future Tertiary Treatment

As discussed above, wastewater effluent must be treated to a tertiary level to allow for Title 22 unrestricted use for landscape irrigation. Tertiary treatment could be provided at additional new satellite plants constructed near the proposed use areas (similar to the recently constructed North Fresno WRF), and/or could be produced by a new stand-alone wastewater treatment facility

(WWTF), or an upgraded RWRF. These options, as described further below, will be evaluated in the Recycled Water Master Plan.

SEGA Stand-Alone or Satellite Plant

A key benefit of stand-alone or satellite plants is that the recycled water source is closer to the use areas, so that less transmission/distribution pipelines are required to deliver the recycled water. The City is considering building a stand-alone/satellite WWTF in the Southeast Growth Area (SEGA) of the City. A possible location for the plant has been identified within the SEGA planning area. However, at this time, the exact location and capacity of the plant is not known.

RWRF Tertiary Plant

The 1996 RWRF Master Plan allowed for possible future tertiary treatment facilities to be added to the RWRF. These new facilities would include additional filtration and disinfection facilities. Although no such facilities are currently required, the infrastructure and piping layout at the RWRF does have provisions for the integration of such new facilities. These future treatment facilities would be modular to allow for only a portion of the total effluent flow to undergo tertiary treatment. At this time, the City plans to build facilities to treat a portion of the RWRF secondary effluent to the disinfected-tertiary level. The capacity of the RWRF tertiary plant is estimated to be about 10 mgd[3] (11,200 af/yr). The recycled water would then be distributed from the RWRF to various users.

RECYCLED WATER MASTER PLAN

As noted above, previous planning efforts concluded that recycled water was not economical due to limited use areas located in scattered locations throughout the City. With the proposed Southeast Growth Area, and other new proposed development areas in and around the City, the potential for future recycled water use has increased significantly, and recycled water should now be considered as a key component of the City's future water supply plan.

To fully evaluate the potential for future recycled water use, a comprehensive Recycled Water Master Plan is being prepared in parallel with this Metro Plan Update.

The Recycled Water Master Plan is anticipated to include the following:

- Identification of recycled water use areas within the City's new development areas through buildout of the City's 2025 General Plan (these should include landscaped areas such as parks, sports fields, golf courses, common areas, and roadway medians, as well as other non-potable water uses including industrial uses, cooling systems, car washes, etc.)

[3] Source: Carollo Engineers, TM 2-2 for Fresno Metro Plan, April 28, 2008.

- Identification of existing landscaped areas and facilities with existing "non-potable type" water uses (i.e., cooling systems, industrial uses, car washes) within the City Limits which can be converted from potable water irrigation/use to recycled water irrigation/use;
- Identification of regulatory requirements;
- Development of refined recycled water demand projections through the year 2025;
- Development of a plan to convert existing sites/facilities from potable water use to recycled water use, including an approach for working with existing property owners to educate them about the need for and benefits of conversion to recycled water, and an assessment of the irrigation system/facility improvements required to convert from potable water use to recycled water use;
- Identification of recycled water treatment needs, including recommendations for new stand-alone, satellite plants and/or expansion of the RWRF to allow for production of tertiary-treated recycled water to meet the projected recycled water demands;
- Identification of recycled water marketing opportunities within and around the Fresno metropolitan area;
- Determination of pipeline sizes and alignments for a recycled water backbone transmission and distribution system to deliver recycled water supplies to the proposed use areas, including the large, regional intentional recharge basins;
- Development of a specific "action plan" which, if implemented, would allow the City to extract and use highly-treated recycled water which has been previously intentionally recharged in the City's regional recharge basins;
- Estimation of capital and annual operations and maintenance (O&M) costs for the recommended recycled water infrastructure; and
- Development of a prioritized recycled water capital improvement program (CIP) to serve as a roadmap for future recycled water system improvements.

REQUIRED INFRASTRUCTURE AND COSTS

Evaluation of the required infrastructure, and associated costs, to support this future recycled water supply will be provided in the Recycled Water Master Plan.

CHAPTER 8. FUTURE NEW WATER SUPPLY SOURCES

As described in this Phase 2 Report, with the assumed completion of the residential water metering program and the implementation of additional water conservation measures, the City currently has adequate available water supplies to meet the water demands anticipated at buildout of the City's 2025 General Plan. Furthermore, as discussed in Chapter 2, these existing water supplies may be capable of meeting the demands of additional future development within the City if per capita water uses within the City can be further reduced (beyond the reductions assumed in this Metro Plan Update).

Nonetheless, the pursuit and acquisition of new water supply sources is critical. The maintenance of water conservation savings on a long-term basis can be difficult and requires on-going support of existing programs and continuous development of new programs. Furthermore, the effectiveness of the City's recharge program is subject to numerous variables and uncertainties. These issues, together with the regulatory environment and the potential impacts of future climate change, drive the need for the City to pursue and acquire new water supply sources.

This chapter presents a description of potential future water supply sources which the City should consider pursuing to increase the diversity and reliability of the City's water supply portfolio. Although the exact timing of the need for such new water supplies is uncertain and can only be determined in the future based on future General Plan updates, actual water demand trends and per capita water use within the City, the acquisition of new water supplies can be a lengthy process requiring numerous technical studies and feasibility evaluations, extensive negotiations and detailed environmental analysis. As such, as opportunities for new water supplies arise, the City should actively evaluate and pursue them, if appropriate.

NEW WATER SUPPLY OBJECTIVE, GOALS, AND POLICIES

As described in Chapter 3, as part of the City's future water supply program, the City has proposed a number of specific objectives, goals, and policies. The specific objectives, goals, and policies related to future new water supply include the following:

New Water Supply Objectives

- Consider water conservation as an additional water supply source, by reducing projected future demands and the need for future new water supplies;
- Evaluate and, if appropriate, pursue and acquire new surface water and/or other water supply sources to increase the diversity and reliability of the City's water supply portfolio; and
- Implement a groundwater banking program.

New Water Supply Goals

- Because the quantity and timing of future new water supplies is uncertain at this time, no specific goals for the acquisition of new water supplies can be established at this time;
- The need for and timing of future new water supplies should be assessed once future growth plans beyond buildout of the 2025 General Plan are determined.

New Water Supply Policies

- Initiate/continue discussions with FID regarding water allocations to the City;
- Continue to track opportunities to participate in Temperance Flat Dam and/or other new water supply projects;
- Consider implementing a groundwater banking program;
- Require new development projects to participate in efforts to bring new, reliable water supplies to the City; and
- Further develop partnerships with FID, Clovis, and others (including those outside the region) to maximize available water resources.

POTENTIAL NEW WATER SUPPLIES

The following potential new water supplies are discussed below:

- Additional surface water supplies from FID;
- New surface water supplies from the Temperance Flat Dam Project;
- Groundwater banking program;
- Water supply purchases on the open market; and
- Additional recycled water.

In addition, the potential for additional water conservation in the future is discussed as a way to reduce the need for future new water supplies.

Additional Surface Water Supplies from FID

As described in the Metro Plan Update Phase 1 Report, the City receives a portion of its surface water supplies from FID. Most of this supply is from FID's Kings River entitlements and USBR Class 2 water. However, the City is also entitled to receive surface water supplies from FID based on the 1976 wastewater recycled water exchange agreement. The agreement provides for the City to extract groundwater developed through the percolation of treated wastewater effluent and pump it into FID canals for delivery to downstream FID users. In return, the agreement states that FID will provide the City with surface water from either its Kings River entitlements or its Class 2 USBR water "insofar as is feasible and practical." The quantity of surface water that FID is required to provide is limited to 46 percent of the groundwater that the City pumps into FID's delivery canal. The contract also limits the annual quantity that can be pumped into FID's canals to 30,000 af/yr, or 100,000 acre-feet over a 10-year period. Based on the 30,000 af/yr annual contract quantity, this equates to 13,800 af/yr of surface water supplies for the City (46 percent of 30,000 af/yr). As described in the Metro Plan Update Phase 1 Report, this 13,800 af/yr is considered to be part of the City's existing available surface water supplies.

It may be possible, through future negotiations with FID, to modify the existing agreements with FID to obtain additional surface water supplies, either from an increased portion of FID's Kings River entitlements or USBR Class 2 water, or through modification of the wastewater recycled water exchange agreement. Subject to City/FID negotiations and agreements, potential modifications to the wastewater recycled exchange agreement might include one or more of the following changes:

- Increasing the annual amount of water that can be pumped into FID's canals (current limit is 30,000 af/yr); and/or
- Increasing or eliminating the 10-year total quantity that can be pumped into FID's canals (current limit is 100,000 acre-feet); and/or
- Increasing the percent return of surface water supplies (current percent return of surface water supplies is 46 percent of the groundwater pumped).

As discussed above, any proposed modifications to the existing agreement between the City and FID are subject to negotiation and mutual agreement by the City and FID. However, as an example, if the annual amount of water pumped into the FID canals was increased to 75,000 af/yr by 2030[1], the 10-year limit was eliminated or increased, and the percent return was increased to 60 percent, the City could potentially receive 45,000 af/yr of surface water supplies (60 percent of 75,000 af/yr) from FID through a modified wastewater recycled water exchange agreement. This could provide 31,200 af/yr of additional surface water supplies from FID (45,000 af/yr minus 13,800 af/yr), beyond the existing 13,800 af/yr based on the current City/FID agreement.

New Surface Water Supplies from the Temperance Flat Dam Project

The Temperance Flat Dam Project is a new multi-objective surface storage project being proposed by the California Department of Water Resources (DWR) and the United States Bureau of Reclamation (USBR) as part of the Upper San Joaquin River Basin Storage Investigation. The surface storage site is located northeast of Fresno on the Upper San Joaquin River above Friant Dam. Several alternatives for the proposed project are being evaluated. The estimated capacity of the new reservoir is 1.3 million acre-feet, with an estimated average yield between 165,000 and 183,000 acre-feet per year, depending on the benefit emphasis of the project[2].

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[1] Based on the projected quantity of treated effluent percolated to groundwater in 2030 (100,500 af/yr) (Metro Plan Update Phase 1 Report Table 6-6) less the proposed tertiary treated effluent (recycled water) to be used for landscape irrigation (25,000 af/yr).

[2] Temperance Flat Frequently Asked Questions, California Department of Water Resources (www.water.ca.gov), September 2007.

The USBR completed a Plan Formulation Report for the Upper San Joaquin River Basin Storage Investigation in October 2008. If Congress and the State approve the projects, and authorize and appropriate construction funds immediately following completion of the Feasibility Report/EIR-EIS, project construction could begin by about 2012 and be completed in 5 to 7 years. Final engineering design, preparation of construction documents, acquisition of lands and rights, and construction permitting would precede construction. Project operation could potentially begin by 2017 to 2019[3].

If the project is determined to be feasible and moves ahead, the City could become a potential partner in the Temperance Flat project, which could provide the City with additional future water supplies. However, at this time, the terms and conditions of such a potential future partnership are unknown and the quantity of water which could potentially be available to the City cannot be determined.

Groundwater Banking Program

In the future, the City should consider the use of surplus surface water supplies for a groundwater banking program to allow for storage of surplus surface water supplies (beyond those required for groundwater recharge to balance groundwater operations) for later use in dry years. Such a program would require the construction of a new, dedicated groundwater recharge facility with associated wells and/or ASR injection/extraction wells, and transmission system facilities, which could be used for storage and then future extraction of surplus surface water supplies during dry years.

The City may also wish to participate in an existing established water banking program, such as the Kern Water Bank or the Semitropic Water Storage District Water Bank.

Water Supply Purchases on the Open Market

In the future, it may be possible for the City to purchase water on the open market from other agencies, such as FID or other agencies. These market purchases are typically just for one year of supply, but may have options to extend terms and provide for multiple years of supply.

Additional Recycled Water

In the future, it may be possible to expand the use of recycled water, to further offset potable water demands, beyond the 25,000 af/yr assumed in this Metro Plan Update. The Recycled Water Master Plan should evaluate the potential for this additional recycled water use (beyond the 25,000 af/yr proposed at General Plan buildout), in addition to potential future recycled water marketing opportunities.

[3] Temperance Flat Frequently Asked Questions, California Department of Water Resources (www.water.ca.gov), September 2007.

Additional Water Conservation

As described in Chapter 4 of this Phase 2 Report, water conservation is a critical component of the City's future water supply plan. Along with residential water metering, an overall water demand reduction of 10 percent due to additional conservation (5 percent by 2010 and another 5 percent by 2020) is embedded in the plan. However, if additional conservation were to be achieved, beyond what has already been included, the need for future new water supplies could be reduced.

Table 8-1 provides a summary of the potential new water supplies available to the City in the future.

Table 8-1. Potential New Water Supplies Available to the City

New Water Supply Name	Year Available	Future Quantity Available, af/yr
Additional Surface Water Supplies from FID	To be determined pending negotiations with FID	To be determined
New Surface Water Supplies from Temperance Flat Dam/Reservoir	Possibly 2017 to 2019 (pending completion of feasibility report and EIR/EIS)	To be determined
Groundwater Banking Program	To be determined	To be determined
Water Supply Purchases on the Open Market	To be determined	To be determined
Additional Recycled Water	To be determined	To be determined
Additional Water Conservation	To be determined	To be determined

INCORPORATION OF FUTURE NEW WATER SUPPLIES

New Surface Water Supplies

The incorporation of future new supplies into the City's system will depend on the source of the new water supply. If additional surface water supplies are available either through a modified agreement with FID, through a new project such as Temperance Flat, or through purchases on the open market, the City would have two choices for its use. The City could either use the new surface water supplies for additional intentional groundwater recharge (which would in turn allow for additional groundwater pumpage), and/or treat the additional surface water supplies for direct use.

The first option would require either additional groundwater recharge facilities or the development of an Aquifer Storage and Recovery (ASR) System.

An alternative to groundwater recharge or injection would be to treat the additional surface water supplies for direct use. The proposed SWTFs discussed in Chapter 6 are sized based on availability of the City's existing surface water supplies and do not have surplus capacity to treat additional available surface water supplies. Therefore, additional surface water treatment capacity would be required to treat the additional surface water supplies for direct use. This additional capacity could be achieved either through further expansion of the Northeast SWTF (beyond a design capacity of 60 mgd), expansion of the Southeast SWTF (beyond a design capacity of 80 mgd), or construction of a third surface water treatment facility, possibly in the southwestern part of the City.

Groundwater Banking Program

The implementation of a potential future groundwater banking program would require additional groundwater recharge facilities (either new recharge basins or ASR injection wells), additional wells for extraction of the banked groundwater, and a transmission system to integrate this supply source with the City's potable water system. The location and size of these facilities will be determined in the future.

Additional Recycled Water Supplies

Incorporation of additional recycled water supplies would require additional or expanded tertiary wastewater treatment facilities, as well as expansion of the recycled water distribution system to serve additional recycled water demand areas.

Table 8-2 provides a summary of the potential new facilities required to incorporate any new supplies into the City's system.

Table 8-2. Potential New Facilities Required to Incorporate Future New Supplies

Future New Supply	Facilities Required
Additional or New Surface Water Supplies from FID, Temperance Flat, Open Market Purchases, or similar project	Additional recharge facilities or ASR injection wells to allow for recharge/injection of available new surface water supplies; and/or Additional surface water treatment capacity to allow for treatment and direct use of available new surface water supplies
Groundwater Banking Program	Additional recharge facilities (either recharge basins or ASR injection wells) and extraction wells to allow for storage of wet year supplies for later extraction and use in dry years
Additional Recycled Water	Additional tertiary wastewater treatment capacity; and Expansion of recycled water distribution system

REQUIRED INFRASTRUCTURE AND COSTS

Additional discussion regarding the required infrastructure to support this future new water supply is provided in Chapter 9 of this Phase 2 Report.

CHAPTER 9. REQUIRED INFRASTRUCTURE TO SUPPORT FUTURE WATER SUPPLY PLAN

INTRODUCTION

This chapter presents the infrastructure and facilities needed to implement the City's proposed future water supply plan. As stated previously, the purpose of this Metro Plan Update is to update and refine the 1996 Fresno Metropolitan Water Resources Management Plan (1996 Metro Plan), taking into consideration available new data and conditions, and accommodating physical and institutional changes that have occurred since the 1996 Metro Plan was prepared. The completed Metro Plan Update will facilitate the City's future water resources decisions and capital improvement planning, and will assist in satisfying eligibility requirements for State funding.

The required facilities were estimated based on the Future Water Supply Plan described in Chapter 3. For purposes of this analysis, future demands would be met through a more balanced combination of groundwater production facilities, surface water treatment facilities, the recycled water system, and additional water conservation.

This chapter presents the facility sizing and estimated capital and operating costs for the following project components:

- Surface Water Treatment;
- Groundwater Production and Treatment;
- Potable Regional Water Transmission and Transmission Grid Main (TGM) System;
- Potable Water Storage; and
- Groundwater Recharge.

These topics are discussed in more detail below.

SURFACE WATER TREATMENT

For purposes of estimating the capacity of the required facilities, the surface water production capacity (average 120 mgd) was sized to deliver an annual volume of 123,400 af by 2020 with a one-month shut down in December for supply canal cleaning and maintenance and SWTF maintenance, as described in Chapter 6. The annual capacity would remain the same from 2020 through 2060. Because the 2025 winter demands are less than the eleven-month average, the surface water treatment plants will have to be sized to deliver a flow greater than the eleven-month average during the summer high demand period. The required flow has been estimated by West Yost to be 127 mgd. The combined flow from the two proposed (one expanded, one new) surface water treatment facilities would be approximately 127 mgd from March through November. Because some water is lost during treatment for backwash and other uses, it is recommended that the treatment train be sized for ten percent greater than the required production capacity. Therefore, the surface water treatment facilities are assumed to be designed for a total capacity of 140 mgd, with an eleven-month average production rate of 120 mgd. The timing of the expansion and new construction was described in Chapter 6 and is summarized in Table 9-1.

Table 9-1. Projected Schedule for Surface Water Treatment Facility Expansion

Milestone Date	Description	Added Design Capacity, mgd
Current Conditions	Existing Northeast SWTF	<30
2010	Operational Improvements to Northeast SWTF	30
2015	Proposed New Southeast SWTF	80
2020	Expansion of Northeast SWTF	30[(a)]
Future (to be determined)	New Southwest SWTF	10 to 20 (to be determined)

(a) For a total design capacity of 60 mgd at the Northeast SWTF.

GROUNDWATER PRODUCTION AND TREATMENT

It is the City's intent to balance the amount of water extracted by the City from the groundwater basin with the amount of water recharged by the City, whether the recharge is natural or intentional. The Future Water Supply Plan described in Chapter 3 included provision for maintaining the City's existing recharge capacity and increasing it to achieve and maintain balanced groundwater operations within the City. This section summarizes the required groundwater production capacity, followed by the projected need for groundwater treatment.

Groundwater Production

The groundwater production capacity will be required to provide the difference between the projected peak-hour system demand and the production capacity of the other available water supplies. Even though the average annual required groundwater production does not increase beyond the projected 2015 production quantity, additional groundwater delivery capacity will be required to serve growing peak hour and high demand periods. The required increase in groundwater delivery capacity is provided in Table 9-2, assuming no additional potable water distribution system storage. With added storage and booster pump stations to serve peak-hour demands, a lower groundwater production capacity would be needed.

Table 9-2. Calculation of Total Required Groundwater Capacity

Water Supply or Demand	2005	2010	2015	2020	2025
Annual Demand/Supply, thousand af [(a)]	157.6	163.3	189.3	206.4	234.4
Average Day Demand, mgd[(b)]	141	146	169	184	209
Peak Hour Demand, mgd[(c)]	408	422	490	534	607
Surface Water Production Capacity, mgd[(d)]	15	30	100	120	120
Non-Potable (Recycled Water) Production Capacity, mgd[(e)]	-	1.4	1.9	1.9	48
Required Firm Groundwater Production Capacity, mgd[(f)]	393	391	388	412	439
Required Total Groundwater Production Capacity, mgd[(g)]	491	489	485	515	549
Existing Total Groundwater Production Capacity, mgd[(h)]	430	430	415	415	415
Required New Total Groundwater Production Capacity, mgd[(i)]	61	59	70	100	134

(a) From Figure 3-3.
(b) Figure 3-3, converted to million gallons per day.
(c) Average day times peak hour peaking factor of 2.9.
(d) From Figure 3-3, converted to mgd, assuming 11 months operation per year.
(e) From Table 9-6, converted to mgd.
(f) Peak hour demand minus surface water and recycled water production capacity.
(g) Firm groundwater capacity divided by 0.8 to account for 20 percent of groundwater production capacity out of service, as directed by City staff.
(h) Based on City well data, 15 mgd capacity removed when Southeast SWTF placed into service.
(i) Required Total Capacity minus Existing Total Capacity.

West Yost calculated the required groundwater production capacity and number of new wells for each milestone year. For purposes of this Metro Plan Update, the City directed West Yost to assume that wells located east and north of Highway 99 would have an average production capacity of 800 gpm and wells located south and west of Highway 99 would have an average production capacity of 2,000 gpm. The estimated number of new wells per milestone year is shown in Table 9-3. The additional wells to serve the 2005 demand are those that would have been required to meet the desired goal of serving demands with 20 percent of the wells/production capacity out of service.

Table 9-3. Required Number of New Wells at Milestone Years

Milestone Year	Number of New Wells Southwest of Highway 99 (2,000 gpm)	Number of New Wells Northeast of Highway 99 (800 gpm)	Total Number of New Wells [a]
2005	4	1	5
2010	5	18	23
2015	4	0	4
2020	7	11	18
2025	15	-	15
2025 Total	**35**	**30**	**65**

[a] Groundwater production capacity must be installed prior to the indicated year.

Of the 65 required new wells by 2025, 35 wells would be south and west of Highway 99 and the remaining 30 wells would be north and east of Highway 99. Because of the simplifying assumption regarding expected production capacity in the different zones (e.g. east and north of Highway 99 versus south and west of Highway 99), the projected number of required new wells should be updated frequently as wells are constructed and actual production capacities are determined. The locations of the existing and projected wells are shown on Figure 9-1. The locations for the wells are shown close to the respective demand areas. The final selected location for each well should be based on a combination of factors such as appropriate land use, groundwater production and quality, and the energy required to pump the groundwater into the distribution system.

In addition to the new wells, it was assumed that the City would offset approximately 15 mgd of existing groundwater production capacity when the Southeast SWTF is placed into service, and then maintain the remaining groundwater production capacity of approximately 415 mgd. The City would accomplish maintaining existing capacity through its asset management renewal and replacement program, while reducing required groundwater pumpage to allow for groundwater levels to recover and help bring the City's groundwater operations back into balance.

Groundwater Treatment

As described in the Phase 1 Report, a number of the City's wells are currently being treated or blended to address various groundwater contaminants. Thirty (30) active wells and eight (8) inactive wells have current wellhead treatment (either granular activated carbon (GAC) or packed tower aeration (PTA)) to remove either DBCP or TCE. Also, several of the wells are being blended to address high nitrate concentrations. For purposes of this study, it has been assumed that budgeting for these "blending" facilities has already been accounted for in the City's existing capital improvement program.

However, there are also a number of additional wells which will require wellhead treatment to treat for detectable TCP concentrations. It should be noted that while no current MCL exists for TCP, the City has currently identified thirty-seven (37) existing City wells with TCP concentrations that exceed the DPH action level of 0.005 ppb. For purposes of this study, it was assumed that a total of 40 existing wells will require additional wellhead treatment for TCP removal between now and 2025 (this includes the 37 wells identified by the City plus an allowance for 3 additional, as of yet undetermined wells). However, there is virtually no data from operating systems removing TCP from public drinking water supplies. Since the City may be required to remove all detectable levels of TCP from its drinking water (i.e., 5 parts per trillion, ppt), this may have a significant effect on the amount of carbon required to filter the water. It is hoped that future studies will provide the data to more accurately estimate operating costs. For the purposes of this Metro Plan Update, GAC treatment has been assumed for TCP removal to provide a "place holder" for TCP treatment needs.

In addition to the contaminants of concern identified in the Phase 1 Report, methyl tert-butyl ether (MTBE) has been detected in several City wells. MTBE is a gasoline additive that has become a contaminant of concern in California and throughout the United States as a result of leaking underground gasoline storage tanks. The City is in the process of evaluating the situation and deciding how to move forward to address the issue. Due to the preliminary nature of the current on-going evaluations, groundwater treatment costs to address MTBE have not been included in this Phase 2 Report.

Including the projected 40 wells with GAC treatment for TCP removal, there will be approximately 79 existing active wells (30 percent of all active wells) with treatment or blending plans. It is assumed that some future wells would need treatment as well. Because of the increased flexibility in locating wells, and the fact that most identified plumes are within the existing City limits, it is assumed that only 15 percent of the 65 future wells (10 wells) would require some form of wellhead treatment. The most common form of treatment is GAC for removal of organics. It is assumed that 75 percent of the 10 new wells requiring treatment (7 wells) would have a GAC treatment system installed. The remaining 3 new wells requiring treatment would receive treatment for inorganic contaminant removal.

Common treatment methods for the removal of inorganic compounds (including arsenic, chromium and nitrate) include reverse osmosis and ion exchange (see previous discussion in Chapter 5). Reverse osmosis, although quite effective for the removal of inorganic compounds, can be extremely expensive due to brine disposal costs (see Appendix B). Ion exchange can be somewhat less effective than reverse osmosis (depending on the compound and concentrations to be treated), but is significantly less expensive than reverse osmosis. Therefore, for purposes of this Phase 2 Report, ion exchange has been assumed as the preferred treatment technology for removal of inorganic compounds.

Carollo Engineers prepared an estimate of the capital and operating costs for wellhead treatment (Carollo TM 2-6, included in Appendix B). The estimated wellhead treatment requirement of future wells is shown in Table 9-4.

Table 9-4. Estimated Groundwater Treatment on Future Groundwater Wells

Well Location	GAC Treatment	Ion Exchange Treatment [a]	Total
2025 Southwest Wells[b]	4	1	5
2025 Northeast Wells[c]	3	2	5
2025 Total	**7**	**3**	**10**

(a) As described above, an alternative technology for removal of inorganic compounds is reverse osmosis. However, the cost for reverse osmosis treatment is extremely high due to the cost of brine disposal.
(b) Numbers represent 15% of 35 new wells in southwest by 2025.
(c) Numbers represent 15% of 30 new wells in northeast by 2025.

By 2025, it was assumed that four wells in the southwest and three wells in the northeast would receive GAC treatment systems, and one additional well in the southwest and two wells in the northeast would receive ion exchange treatment.

POTABLE WATER SYSTEM

To optimize use of the various water supplies, the City's potable water transmission and distribution system must be converted from a system that was originally based on a distributed groundwater system to a system that will have a substantial amount of surface water supply provided from two point sources (the existing and proposed SWTFs). The locations of the major two proposed surface water treatment facilities are:

- North Chestnut Avenue, north of East Behymer Avenue in north Fresno (at the location of the existing Northeast Surface Water Treatment Facility), and
- Northwest corner of Olive Avenue and Armstrong Avenue in southeast Fresno.

The City's existing water distribution system hydraulic computer model was updated to include the proposed surface water treatment facility upgrades, and the proposed water transmission grid system. Demands were re-allocated in the model to reflect the proposed additional water conservation measures, which are anticipated to reduce water demand by an additional 10 percent by 2020, and the use of recycled water to meet non-potable demands.

The model was run for both 2025 projected peak hour demand and projected 2025 minimum month demand. The minimum month demand scenario was created to simulate demand conditions during the minimum month of February when no wells would be operating. The surface water distribution system would have to deliver water to the entire service area during the winter.

There are four major components to the City's potable water transmission and distribution systems. These four components are:

- Regional Transmission Main System – Large diameter (24-inches and greater) pipelines that convey potable water from the surface water treatment plants to the TGM system.

- TGM System – Large diameter (16-inch) pipelines that convey potable water from the Regional Transmission Mains to the smaller distribution system pipes. Although it is not intended that the TGM system would have individual customer service taps, under special circumstances, taps could be allowed.
- Distribution System – Smaller diameter (14 inches and less) pipelines that convey potable water from the TGM system, and sometimes from the Regional Transmission Main system, to individual customers.
- Distribution System Storage and Booster Pumps – The City may choose to construct distribution system storage and booster pumps to improve peak-hour service pressures and potable water delivery.

These components are discussed in more detail below.

Potable Regional Water Transmission and Transmission Grid Main (TGM) System

A major north/south regional transmission system in Chestnut Avenue is proposed to connect the two treatment plants. Part of this transmission system has already been constructed. Other major (24-inch diameter to 48-inch diameter) transmission mains would be located in North Maple Avenue, Nees Avenue, Olive Avenue, McKinley Avenue, North Avenue, G Street, Walnut Avenue, Bullard Avenue, and Temperance Avenue, as shown on Figure 9-1.

A summary of the proposed regional transmission main system and TGM pipelines that will be needed to serve the 2025 SOI is presented in Table 9-5.

Table 9-5. Potable Water Transmission Main Summary

Pipe Diameter, inches	Length, feet
Regional Water Transmission Mains:	
48-inch	12,900
42-inch	59,100
36-inch	47,100
30-inch	39,200
24-inch	107,500
Subtotal	265,800
Transmission Grid Mains (TGMs):	
16-inch	506,200
Subtotal	506,200
Total	772,000

The regional transmission system pipelines would not have individual customer service taps. Turnouts from the regional transmission system will provide water to the TGM system.

The existing TGM system will be expanded and strengthened. A grid of 16-inch diameter TGM pipelines will provide water to the local distribution systems. The 16-inch diameter TGM system is also shown on Figure 9-1.

Potable Water Distribution System Storage

As stated above in the groundwater capacity discussion, it is assumed that the surface water and recycled water supplies would be delivered at a near constant rate throughout each day at the rates shown in Table 9-2. Peak-hour demands would be met with groundwater production. To reduce the number of wells required, and to address specific local peak-hour demand service pressure problems, potable water distribution system storage and booster pumps would also be constructed.

The City currently has a 1.5 million gallon clearwell at the Northeast SWTF and a 2 million gallon Southeast tank “T1” located near Clovis Avenue and California Avenue. Locations of proposed new storage tanks are shown on Figure 9-1 and are described as follows:

- New Southeast Storage Tank “T2”
  - Capacity = approximately 2 million gallons
  - Next to existing 2 million gallon Southeast tank “T1” near Clovis Avenue and California Avenue
  - Already budgeted by the City and funded through other revenue sources/accounts
- New Southeast Storage Tank “T3”
  - Capacity = approximately 3 million gallons
  - Near Dakota Avenue and Temperance Avenue
  - Site also includes a packaged water treatment plant, building and emergency generator
  - Already designed; already budgeted by the City and funded through other revenue sources/accounts
- New Downtown Storage Tank “T4”
  - Capacity = 3 million gallons
  - Currently being designed; already budgeted by the City and funded through other revenue sources/accounts
- New Eastside Storage Tank “T5”
  - Capacity = assumed to be 4 million gallons (to be confirmed in the Water Master Plan)
  - Possibly near Chestnut Avenue and Ashlan Avenue
- New Westside Storage Tank “T6”
  - Capacity = assumed to be 4 million gallons (to be confirmed in the Water Master Plan)
  - Possibly near Highway 99 at Ashlan Avenue

In addition to distribution system storage, it is recommended that each surface water treatment facility include potable water storage to improve operations. Although this potable water storage would not serve peak-hour demands, it could be considered part of the City's emergency storage volume. It has been recommended that an additional 5 million gallons of storage be constructed at the Northeast SWTF, for a total of 6.5 million gallons at that location, and that 6 million gallons of storage be constructed at the new Southeast SWTF.

The need for, capacity and location of future storage facilities will be examined further in the Water Master Plan.

RECYCLED WATER TREATMENT, STORAGE AND TGM SYSTEM

The City is currently developing a Recycled Water Master Plan which will recommend a preferred recycled water plan that will offset potable water demands by 25,000 acre-feet by the year 2025. A recycled water system designed to offset 25,000 af of potable water used for non-potable purposes would be very extensive, and will require the establishment of City policy to foster sustainability and maximize the use of the City's available water resources. The Recycled Water Master Plan should investigate ways to optimize the cost effectiveness of the recycled water system.

The following describes a conceptual plan for future recycled water infrastructure in the City. This conceptual plan will be refined in the Recycled Water Master Plan.

Estimated Recycled Water Deliveries

The estimated monthly recycled water delivery (to deliver 25,000 af/yr) is shown on Table 9-6 and is based on the relative evapotranspiration values for each month.

The required recycled water delivery capacity is equal to the maximum month (July) demand.

As discussed in Chapter 7, and summarized in Table 9-6, up to approximately 1,250 af of the 25,000 af of recycled water delivered annually is expected to be delivered to the Copper River Ranch Golf Course. The remaining recycled water supply would be supplied to the Southeast Growth Area (SEGA) and other areas of the City for landscape irrigation and other non-potable uses. Because of the difficulty in conveying recycled water across Highway 99 and the railroad, most of the recycled water that is intended to serve the SEGA, and possibly other areas in the vicinity, is likely to be generated at the proposed Southeast WWTF located within the SEGA planning area. The treatment facilities required to produce tertiary treated water are described in Chapter 7. Further evaluation of future recycled water use areas and required facilities will be provided in the Recycled Water Master Plan.

Table 9-6. Monthly Recycled Water Deliveries, af

Month	Approximate Percent of Annual Delivery	Monthly Delivery from Copper River WWTP	Monthly Delivery from SEGA WWTP[(a)]	Monthly Delivery from RWRF[(a)]	Total Monthly Delivery
January	-	-	-	-	-
February	-	-	-	-	-
March	-	-	-	-	-
April	11.6	145	1,885	870	2,900
May	15.5	194	2,519	1,163	3,875
June	17.7	221	2,876	1,328	4,425
July	18.3	229	2,974	1,373	4,575
August	16.2	203	2,633	1,215	4,050
September	12.3	154	1,999	923	3,075
October	8.4	105	1,365	630	2,100
November	-	-	-	-	-
December	-	-	-	-	-
Total	100	1,250	16,250	7,500	25,000

(a) Based on the anticipated irrigation demand of the assumed service areas as described in the text.

Recycled Water Distribution

It is assumed that the tertiary-treated recycled water would be conveyed via a core backbone TGM system and that individual customers would be responsible for constructing the smaller diameter distribution pipelines to deliver the water to the area of use. This recycled water would be used to offset the use of potable water being used for non-potable purposes, such as landscape irrigation. The recycled water distribution system should be designed to convey the peak demands, as pumped from the treatment facilities. Constructing storage tanks at the northern end of the recycled water distribution system would allow the City to size the treatment plant pumps for maximum day demands and provide demand peaking from the storage tank booster pumps and thereby reduce distribution pipe sizes.

The alignments and diameters of backbone recycled water pipelines and the size and location of recycled water diurnal storage tanks and booster pumps should be determined in the Recycled Water Master Plan project.

Recycled Water Seasonal Storage

Seasonal storage of recycled water can be a major issue in the planning and design of a recycled water system. Possible ways to reduce the required seasonal storage include the following:

- Increase the proposed capacity of the SEGA WWTF.
- Re-direct a substantial amount of wastewater influent flow from the southeast side of the City, and from Clovis, to allow the City to defer capacity increases at the RWRF.

- Provide an inter-tie between the two recycled water systems, which would include a booster pump to pump recycled water from the southwest system into the southeast system and a large pipeline crossing Highway 99 and the railroad.

These seasonal storage alternatives should be evaluated in the Recycled Water Master Plan.

RECHARGE FACILITIES

As described in Chapter 5, if the City can maintain its current intentional recharge quantities of about 54,600 af/yr, it would have sufficient intentional recharge to offset the proposed future groundwater pumpage quantities through 2025 (assuming that the proposed additional surface water treatment capacity is constructed and is available to allow for reduced groundwater pumpage). Therefore, the construction of additional recharge basins is not required to maintain balanced groundwater operations.

However, additional recharge capacity would be beneficial to provide additional operational flexibility and allow for additional recharge (beyond that required to balance groundwater operations) in years where surplus surface water supplies are available. West Yost is recommending that the City increase its intentional recharge capacity to allow it to take advantage of available surface water supplies in normal years, which would require an additional recharge capacity of about 20,500 af/yr, or about 340 acres of additional recharge area (conservatively assuming a recharge capacity of 0.2 acre-feet per acre per day). Allowing for set-backs and internal roadways, it is estimated that 425 acres of land would be required (assumes a 25 percent increase over the area actually needed for recharge activities).This additional recharge area can be acquired through either acquisition of new properties or expansion of existing recharge facilities.

In addition to the City's intentional recharge facilities discussed above, other agencies in the region may also have plans to intentionally recharge groundwater. As discussed in Chapter 5, a survey conducted by Blair, Church and Flynn Consulting Engineers (BCF) of local agencies found that Fresno Metropolitan Flood Control District plans to work with the City of Fresno to identify future recharge sites. BCF also reported that neither Fresno Irrigation District nor the City of Clovis has current plans to construct additional intentional recharge facilities.

As described in Chapter 5, a potential alternative to the construction of new recharge areas may be the development of an Aquifer Storage and Recovery (ASR) Well System.

CAPITAL COSTS FOR REQUIRED INFRASTRUCTURE

Estimated capital project costs are discussed below. The base and total costs for each component of the required infrastructure are discussed separately, followed by an estimate of the total Future Water Supply Plan cost. The total cost of each component includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs). It was estimated for the Phase 1 Report, and again in this Phase 2 Report, that these added costs would be approximately 50 percent of the base cost.

Surface Water Treatment

For purposes of this cost estimate, it is assumed that the improvements needed to increase the existing Northeast Surface Water Treatment Facility production capacity to a total capacity of 30 mgd has already been budgeted and does not need to be included herein. The costs to construct the 80 mgd design capacity Southeast SWTF and to increase the design capacity of the Northeast SWTF to 60 mgd are summarized in Table 9-7.

Table 9-7. Estimated Cost of Surface Water Treatment Projects

Milestone Date	Description	Added Capacity (design), mgd	Estimated Cost[a], million dollars
Current Conditions	Existing Northeast SWTF	<30	0.0[d]
2010	Operational Improvements to Northeast SWTF	30	0.0[d]
2015	Proposed New Southeast SWTF	80	201.8
2020	Expansion of Northeast SWTF	30[b]	62.6
		Subtotal	$264.4
		Contingencies and Other Fees (50%)[c]	132.2
		Total Cost	**$396.6**

(a) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762 and are described in Carollo TM 2-6 (Appendix B).
(b) For a total design capacity of 60 mgd at the Northeast SWTF.
(c) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost.
(d) Funding for this project is assumed to be already accounted for in the City's existing CIP budget, and is therefore not included in this study.

These estimated costs are presented in more detail in Carollo's TM 2-6 (Appendix B).

Groundwater Production

As stated above in Table 9-3, an estimated 65 wells will be required prior to 2025. At a unit cost of $523,400 per well ($460,000 per well from Phase 1 Report multiplied by ratio between May 2010 and June 2006 ENR CCI), the groundwater well production base cost is $51.0 million including contingencies and other project costs, as shown in Table 9-8.

Table 9-8. Estimated Cost of Groundwater Production Facilities by 2025

Item	Quantity	Unit Cost, dollars per each	Extended Cost[c], Million dollars
Wells Required By 2025	65[a]	$523,400[b]	34.0
Contingencies and Other Project Fees (50%)[d]			17.0
Total Cost			**$51.0**

(a) See Table 9-3.
(b) Based on the same cost per well as the Phase 1 Report ($460,000), multiplied by the ratio between the June 2006 ENR CCI for 20 Cities of 7700 and the May 2010 ENR CCI for 20 Cities of 8762.
(c) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762.
(d) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost.

Groundwater Treatment

Estimated groundwater treatment costs have been developed by Carollo Engineers (Carollo TM 2-6, Appendix B).

As described previously, it is assumed that the 37 known wells with measurable TCP concentrations, plus an allowance for three additional wells (40 wells total), would require treatment systems to be installed for the removal of TCP. However, there is virtually no data from operating systems removing TCP from public drinking water supplies. Since the City may be required to remove all detectable levels of TCP from its drinking water (i.e., 5 parts per trillion, ppt), this may have a significant effect on the amount of carbon required to filter the water. It is hoped that future studies will provide the data to more accurately estimate operating costs. For the purposes of this Metro Plan Update, GAC treatment has been assumed for TCP removal to provide a "place holder" for TCP treatment needs.

The total estimated capacity of the 37 identified existing wells is approximately 25 mgd (based on their actual production during a maximum day demand condition). Based on the average production of the identified wells of about 470 gpm each (25 mgd divided by 37 wells), and a wellhead treatment cost of approximately $1.7 million per 800 gpm of production capacity, the cost to provide wellhead treatment on the 40 additional wells between now and 2025 is estimated to be $59.9 million including contingencies and other project fees. It should be noted that this cost does not include costs to treat for other additional contaminants or other additional wells (beyond the 40 existing wells assumed above).

The estimated cost to treat future wells with GAC and ion exchange treatment is summarized in Tables 9-9 and 9-10.

Table 9-9. Estimated Cost of Granular Activated Carbon Treatment on Future Groundwater Wells

Well Location	Quantity[a]	Nominal Capacity per Well, gpm	Unit Cost of Treatment Per Well, million dollars[b]	Extended Cost[c], million dollars
2025 Southwest Wells	4	2,000	2.6	10.4
2025 Northeast Wells[b]	3	800	1.7	5.1
Present to 2025 Subtotal				$15.5
Contingencies and Other Project Fees (50%)[d]				7.8
Total Cost of Future Groundwater GAC Treatment Present to 2025 Total Cost				**$23.3**

(a) See Table 9-4.
(b) See Carollo TM 2-6, Appendix B. Costs are based on the May 2010 ENR CCI for 20 Cities of 8762.
(c) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762.
(d) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost.

Table 9-10. Estimated Cost of Ion Exchange Treatment on Future Groundwater Wells

Well Location	Quantity [a]	Nominal Capacity per Well, gpm	Unit Cost of Treatment Per Well, million dollars[b]	Extended Cost[c], million dollars
2025 Southwest Wells	1	2,000	5.9	5.9
2025 Northeast Wells	2	800	4.2	8.4
2025 Subtotal				14.3
Contingencies and Other Project Fees (50%)[d]				7.2
2025 Total Cost				**21.5**

(a) See Table 9-4.
(b) See Carollo TM 2-6, Appendix B. Costs are escalated to the May 2010 ENR CCI for 20 Cities of 8762.
(c) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762.
(d) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost.

The total capital cost for the new wellhead treatment systems is summarized in Table 9-11.

Table 9-11. Summary of Estimated Cost of Wellhead Treatment on Groundwater Wells

Well Location	Estimated Cost[d], million dollars
Existing Wells (TCP), GAC[a]	59.9
2025 Wells, GAC[b]	23.3
2025 Wells, Ion Exchange[c]	21.5
Total Cost of Groundwater Treatment	**$104.7**

(a) From text prior to Table 9-9, for TCP treatment.. This is a preliminary estimate that has a significant level of uncertainty because of the limited data that is currently available from operating TCP treatment facilities. Actual treatment technology to be implemented may be different based on actual water quality parameters and best available treatment technologies for TCP removal.
(b) From Table 9-9 with contingencies added.
(c) From Table 9-10 with contingencies added.
(d) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762 and include Contingencies and Other Project Fees at 50 percent of estimated construction cost.

Regional Water System Transmission and Transmission Grid Main System

The estimated base cost for the water system infrastructure described above is presented in Table 9-12.

Table 9-12. Water System Infrastructure for the Year 2025

Pipeline Diameter, inches	Length, feet	Unit Cost [a], dollars per lineal feet	Extended Cost[b], million dollars
Regional Water Transmission Mains			
48	12,900	728	9.4
42	59,100	592	35.0
36	47,100	498	23.5
30	39,200	401	15.7
24	107,500	302	32.5
		Subtotal	116.1
		Contingencies and Other Project Fees (50%)[c]	58.0
		Total Cost for Regional Transmission Mains	**$174.1**
Transmission Grid Mains (TGMs)			
16	506,200	200	101.2
		Subtotal	101.2
		Contingencies and Other Project Fees (50%)[c]	50.6
		Total Cost for TGMs	**$151.8**
		Total Cost	**$325.9**

(a) Based on the cost per inch-diameter lineal foot as developed by West Yost.
(b) Costs are based on the May 2010 ENR CCI for 20 Cities of 8762.
(c) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost.

Treated Water Storage Facilities

The estimated capital cost of treated water storage facilities is presented in Table 9-13.

Table 9-13. Treated Water Storage Facility Costs

Storage Facility Location	Storage Capacity, million gallons	Unit Cost, dollars per gallon	Extended Cost, million dollars
Northeast SWTF (new clearwell)	5	Included in cost for Northeast SWTF Expansion	
Southeast SWTF (new clearwell)	6	Included in cost for new Southeast SWTF	
Southeast Tank "T2" (next to existing 2 million gallon Tank "T1" near Clovis Avenue and California Avenue)	2	$1.25	$2.50
Southeast Tank "T3"	3	--	$21.0 [a]
Downtown Tank "T4"	3	--	$10.5 [b]
Eastside Tank "T5" (near Chestnut Avenue and Ashlan Avenue)	4 [c]	$1.25	$5.0
Westside Tank "T6" (near Highway 99 at Ashlan Avenue)	4 [c]	$1.25	$5.0
		Subtotal	$44.0
		Contingencies and Other Project Fees (50%)[d]	6.25
		Total Cost	$50.25

(a) Cost for Tank "T3" includes other facilities including packaged water treatment plant, building and emergency generator. Cost based on City of Fresno Water Division 5-Year CIP Summary FY 2011 CIP Budget dated 06/18/10. Cost includes markups and contingencies.
(b) Cost for Tank "T4" includes other facilities including booster pump station. Cost based on City of Fresno Water Division estimates as provided by Cesar Romero (09/29/10 e-mail), Cost includes markups and contingencies.
(c) Assumed to be 4 million gallons. Capacity to be confirmed in the Water Master Plan.
(d) Contingencies and Other Project Fees includes items such as a construction contingency and other project fees (engineering, construction management and program implementation costs), assumed to be equal to 50 percent of the estimated cost. Includes markups to "T2", "T5" and "T6" only.

Recycled Water Facilities

Estimated costs for recycled water treatment, seasonal storage and transmission and TGM system pipelines will be presented in the Recycled Water Master Plan.

Recharge Facilities

As indicated above, West Yost is recommending that the City increase its recharge capacity by about 20,500 af/yr to take advantage of available surface water supplies in normal years. This will require approximately 340 acres of additional recharge area (conservatively assuming a recharge rate of 0.2 acre-feet per acre per day). Allowing for set-backs and internal roadways, it is estimated that 425 acres of land would be required (assumes a 25 percent increase over the area actually needed for recharge activities). Based on a $150,000 per acre purchase price and

$50,000 per acre construction cost, the estimated base cost would be $85.0 million prior to contingencies and other project fees, and $127.5 million including contingencies and other project fees.

Summary of Capital Cost

The capital costs described above are summarized in Table 9-14.

Table 9-14. Estimate of Probable Cost of Required Infrastructure to Support Future Water Supply Plan[a]

Item Description	Estimated Cost to 2025, million dollars[b]
Surface Water Treatment[c]	396.6
Regional Water Transmission System	174.1
TGM System	151.8
Potable Water Storage[d]	50.3
Groundwater Production	51.0
Groundwater Treatment	104.7 [e]
Recycled Water Treatment, Storage and Transmission and TGM System	--[f]
Recharge Facilities	127.5
Total Estimated Project Cost	**$1,056**

(a) Costs do not include Renewal and Replacement (R&R) costs for the City's existing infrastructure.
(b) Based on a May 2010 ENR 20 Cities Construction Cost Index of 8762. All costs include construction contingency, engineering, construction management, and program implementation costs, estimated to be 50%, as documented in the Phase 1 Report.
(c) Includes the new Southeast SWTF and Northeast SWTF expansion. Does not include a potential future Southwest SWTF.
(d) Includes Tanks "T2", "T3","T4", "T5" and "T6". Costs for clearwells are included with Surface Water Treatment.
(e) See Table 9-11. Includes treatment for a number of existing and future City wells. Assumes GAC treatment for TCP removal for 40 of the City's existing wells; however, this is a preliminary estimate that has a significant level of uncertainty because of the limited data that is currently available from operating TCP treatment facilities. Assumes GAC and ion exchange treatment for future wells for other potential contaminants of concern.
(f) To be determined by Recycled Water Master Plan.

For comparative purposes, the No Project Alternative described in the Phase 1 Report indicated a projected capital cost, including contingencies and other fees, of $553 million (Metro Plan Update Phase 1 Report Tables 6-3 and 6-4), based on the June 2006 ENR CCI of 7700. Projecting this value to the May 2010 ENR CCI of 8762 indicates an expected capital cost of roughly $567 million for the No Project Alternative.

OPERATION AND MAINTENANCE COSTS FOR REQUIRED INFRASTRUCTURE

Estimated operation and maintenance (O&M) project costs are discussed below. The O&M cost for each component of the required infrastructure is discussed separately, followed by a summary of O&M costs.

All O&M Costs are based on the target year 2025 production and demand values.

Surface Water Treatment

The Northeast SWTF is expected to treat an average of 50 mgd in eleven out of twelve months per year and the Southeast SWTF is expected to treat an average of 70 mgd in eleven out of twelve months per year. It is assumed each SWTF would be shut down for one month (December) for canal maintenance or SWTF maintenance. Therefore, the total amount of surface water to be treated is 123,400 af, or 40,210 million gallons. At an estimated O&M cost of $639 per million gallons (Carollo TM 2-6, Appendix B) the total annual O&M cost is projected to be approximately $25.7 million. O&M costs for the potential future Southwest SWTF, to be constructed at some time in the future (after 2025), are not included in this analysis.

Groundwater Production

Groundwater production in 2025 is estimated to be approximately 86,000 af/yr. As shown in Table 9-2, the added groundwater capacity is projected to be 24 percent (134/549) of the total capacity. Therefore the projected pumping from the added wells would be approximately 20,640 af (24 percent of 86,000). Assuming an average depth to groundwater of 300 feet (pumping level), an average discharge pressure of 60 psi, and an overall plant efficiency of 70 percent, it is estimated that the total energy use to pump groundwater would be approximately 13.2 million kw-hr per year. At an average power cost of $0.10 per KW-HR, the projected power cost to pump groundwater from the added wells in 2025 is estimated to be $1.3 million.

Other annual O&M costs are anticipated to be approximately 2 percent of the total capital cost, or $1.6 million (0.02 times $79.3 million to 2025), for a total annual O&M cost of $2.9 million.

Groundwater Treatment

O&M cost estimates for groundwater treatment are based on the anticipated average annual pumping for the year 2025.

The 37 existing wells that are assumed to require GAC treatment to remove TCP are expected to pump 1,817 MGY on an annual basis in 2025[1]. Because it is assumed that a total of 40 wells would require GAC treatment for TCP removal, the total estimated annual production volume was multiplied by the ratio of 40/37 to arrive at a total estimated pumped volume of 1,964 MGY.

---

[1] See discussion earlier in this chapter regarding the current uncertainty involving TCP treatment due to virtually no data from operating systems removing TCP from public water supplies.

Additionally, the seven future wells that are projected to require GAC treatment by the year 2025 for the removal of organic compounds (Table 9-9) are expected to produce an additional 1,293 MGY in 2025, based on the projected average annual pumping volume developed in support of the groundwater model, for a total GAC treated volume of 3,257 MGY. At an average cost to treat of $3,500 per MG (Carollo TM 2-6, Appendix B), the estimated annual GAC O&M cost is $11.4 million.

The three future wells requiring ion exchange treatment for the removal of inorganic compounds such as arsenic, chromium and nitrate (Table 9-10) are expected to produce approximately 419 MGY in 2025. At an average treatment cost of $620 per MG (Carollo TM 2-6, Appendix B), the estimated annual ion exchange treatment O&M cost for the year 2025 is anticipated to be approximately $260,000.

Recycled Water Treatment and Seasonal Storage Facilities

Estimated O&M costs for the recycled water treatment and seasonal storage facilities will be presented in the Recycled Water Master Plan.

Groundwater Recharge Facilities

The groundwater recharge facilities would require occasional removal of silt and fines. A value of $0.5 million per year for the additional intentional recharge areas to be completed by 2025 (425 acres) is estimated as a placeholder.

Summary of O&M Costs

A summary of the estimated O&M costs for the year 2025, in present dollars, is shown in Table 9-15.

Table 9-15. Estimate of Probable Cost of Operation and Maintenance of Required Infrastructure to Support Future Water Supply Plan, Year 2025

Item Description	Estimated Annual O&M Cost [(a)], million dollars
Surface Water Treatment[(b)]	25.7
Groundwater Production	2.9
Groundwater Treatment	11.7
Recycled Water Treatment and Storage	--[(c)]
Recharge Facilities	0.5
Total Estimated Annual O&M Cost	**$40.8**

(a) Present dollars.
(b) Includes the new Southeast SWTF and Northeast SWTF expansion. Does not include a potential future Southwest SWTF as it will likely be constructed after 2025.
(c) To be determined by Recycled Water Master Plan.

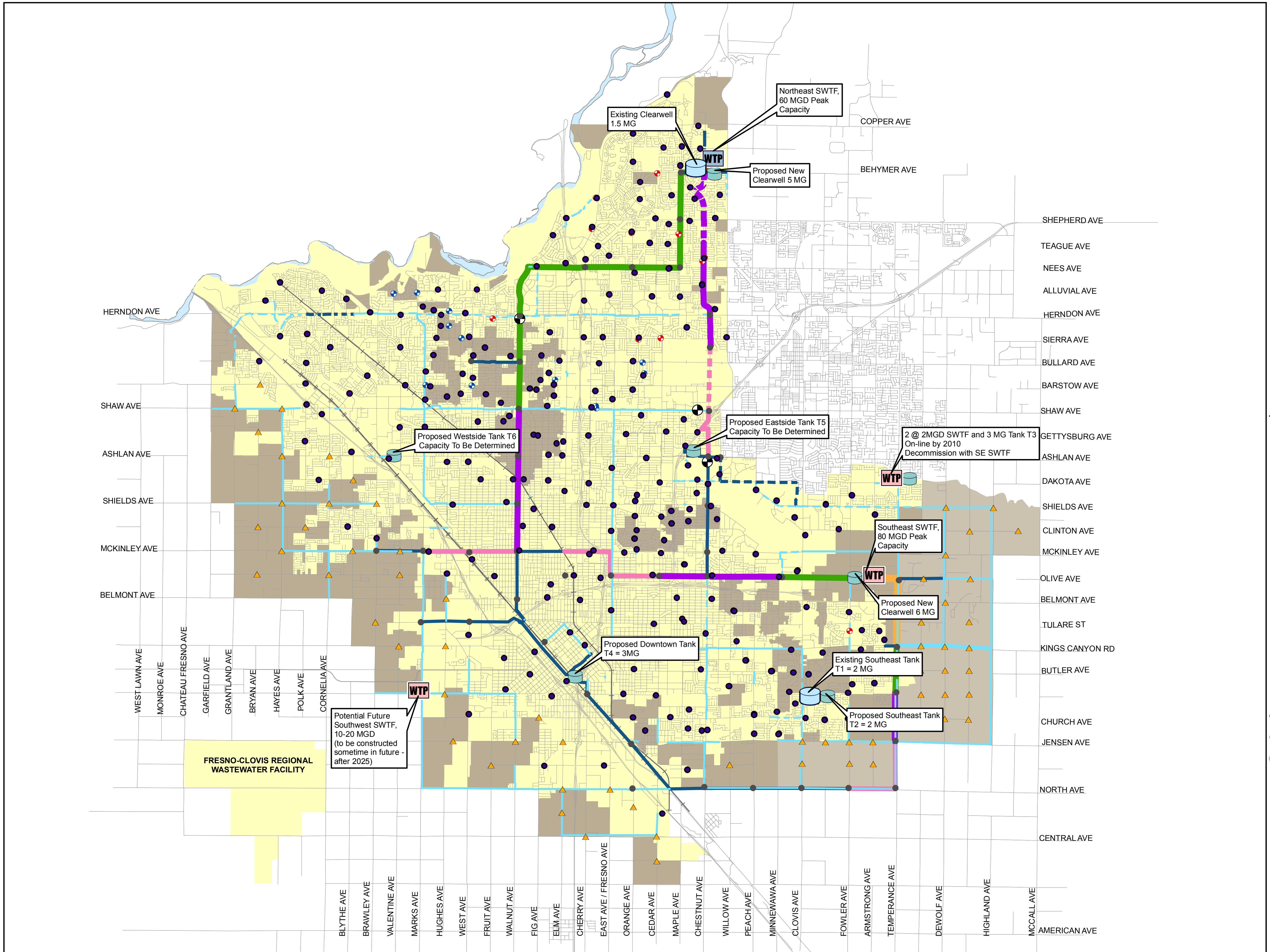

FIGURE 9-1

City of Fresno Metro Plan Update

Phase 2 Report

2025 PROPOSED POTABLE REGIONAL AND TGM WATER INFRASTRUCTURE

N

0 1 2

Scale in Miles

Notes

1. Dashed line indicates an existing pipeline.

LEGEND

- WTP Existing Water Treatment Plant
- Proposed Tank Site
- WTP Future Water Treatment Plant
- Future Pressure Reducing Valve
- TGM Tie-in Location
- Pressure Sustaining Valve
- Fluoride District PRV
- Existing Well
- Future Well 2010-2025
- 16-inch Diameter
- 24-inch Diameter
- 30-inch Diameter
- 36-inch Diameter
- 42-inch Diameter
- 48-inch Diameter
- Existing City Limit
- Fresno Sphere of Influence
- Southeast Growth Area

WEST YOST ASSOCIATES

Consulting Engineers

N:\Shared\Brenda Estrada\439-Fresno Water Mstr Plan\GIS\Figures\CS_Edits\FIG_9-1_2025Infrastructure.mxd 6/14/2010

CHAPTER 10. RECOMMENDED METRO PLAN UPDATE MONITORING AND CORRECTIVE ACTION PROGRAM

As important as having developed a water supply plan to meet the needs of the City's existing and future water customers, is the implementation of a monitoring program to track the progress and success of that water supply plan. Also, a corrective action plan is equally critical. This chapter describes the recommended monitoring program for the City's water supply plan, which involves tracking three key parameters (groundwater balance status, overall per capita water use and residential water metering program progress) and comparing the actual, measured implementation to established interim and long-term goals. This will allow the City to track overall implementation progress of the water supply plan in real time and, if needed, identify the appropriate corrective actions needed to get back on track to achieve the established interim and long-term objectives and goals.

GROUNDWATER BALANCE STATUS

The City's groundwater balance status will be an important measure of progress and success in achieving the overall objectives of the City's water supply plan. Groundwater balance status will be tracked by monitoring the status of groundwater recharge operations in relation to groundwater pumpage, also known as net groundwater recharge, to ensure that annually the City's net groundwater recharge is increasing, and ultimately is approaching balanced groundwater operations.

The City's net groundwater recharge provides a direct measure of the City's groundwater operations (including intentional groundwater recharge and groundwater pumpage), and an indirect measure of the City's other water operations (e.g., the City's use of available surface water supplies for treatment and direct use (which reduces required groundwater pumpage), the City's use of recycled water supplies to offset potable water demands, and the City's use of available surface water supplies for intentional groundwater recharge).

Calculation of Net Groundwater Recharge

The City's net groundwater recharge should be calculated at the beginning of each calendar year for the previous calendar year by summing up the City's total groundwater recharge (both natural and intentional) and subtracting the City's total groundwater pumpage.

The City's net groundwater recharge for 2009 was calculated as follows:

2009 Net Groundwater Recharge =

Total Natural Groundwater Recharge[1] *(17,000 acre-feet for deep percolation + 15,500 acre-feet for seepage from major canals + 21,100 acre-feet for net subsurface boundary inflow = 53,600 acre-feet)*

+ Total Intentional Recharge (54,617 acre-feet) (includes intentional recharge at City facilities, FID facilities and FMFCD facilities)

- Total Groundwater Pumpage (138,254 acre-feet)

= -30,037 acre-feet

Summary of Objectives

As described in Chapter 5, one of the key objectives of the City's water supply plan is to balance the City's groundwater operations by 2025. This means that by 2025, the City's net annual groundwater recharge should increase from its current negative value to a value that is greater than or equal to zero, such that total groundwater recharge (including both natural and intentional recharge within the City's service area) is greater than or equal to the City's groundwater pumpage.

The historical net annual groundwater recharge is shown on Figure 10-1, along with the projected net groundwater recharge through 2025 based on the recommended water supply plan. After 2025, the City's groundwater operations should continue to be balanced and the net groundwater recharge should continue to be greater than or equal to zero.

Recommended Means to Achieve Objectives

The primary means recommended to balance the City's groundwater operations is to maximize the use of available surface water supplies for either treatment and direct use or intentional groundwater recharge, reduce groundwater pumpage, and maximize intentional recharge operations.

Anticipated Trends and Results

As the City maximizes the use of its existing Northeast SWTF to help meet water demands, and implements additional water conservation measures, required groundwater pumpage should decrease. This decrease in required groundwater pumpage, along with the maintenance of current intentional recharge quantities (54,600 af/yr based on 2009 intentional recharge quantities) should result in a gradual increase in the City's net annual groundwater recharge.

[1] Total Natural Groundwater Recharge is based on estimates developed by WRIME for the modeling of the groundwater basin underlying the City. These Natural Groundwater Recharge component values are assumed to remain constant for purposes of this calculation.

However, the biggest increase in net groundwater recharge should occur as a result of the completion of the new 80 mgd Southeast SWTF in 2015 and the 30 mgd expansion of the existing Northeast SWTF in 2020. These increases in the City's surface water treatment capacity should result in significant decreases in required groundwater pumpage by the City, thus increasing the City's net groundwater recharge from its current negative value to a quantity greater than or equal to zero by 2025. These anticipated trends are shown on Figure 10-1.

It should be noted, however, that if these proposed increases in surface water treatment capacity do not become available, or are delayed for any reason, additional intentional recharge will be required to achieve and maintain balanced groundwater operations. Also, after 2025, if additional demands for new customers are approved, additional intentional groundwater recharge will be required to maintain the balanced groundwater operations.

Tracking Tool

Table 10-A, included at the end of this chapter, provides a spreadsheet to track the City's annual net groundwater recharge. Annual water use statistics should be input into the Table 10-A spreadsheet as follows:

- Column 5: Total Intentional Recharge in acre-feet including intentional recharge at the City's facilities, FID's facilities and FMFCD's facilities
- Column 7: Total Groundwater Pumpage by the City in acre-feet
- Column 15: Total Water Demand in acre-feet (calculated as the sum of total annual groundwater production and total annual surface water treatment production) (once recycled water is available, the recycled water demand should also be included in the total water demand)
- Column 19: Total Recycled Water Use by the City in acre-feet
- Column 23: Total Treated Surface Water Production by the City in acre-feet

The annual net groundwater recharge is then calculated in Column 9 along with a comparison to the annual net groundwater recharge goal (Column 10) and percent variance from that goal (Column 12). The percent variance from the goal is then used to determine appropriate corrective actions, if needed. Potential corrective actions are described in Table 10-1.

OVERALL PER CAPITA WATER USE

The City's overall per capita water use is a measure of the City's potable water use trends, specifically the success of its water conservation programs. Because water conservation is such a critical component of the City's water supply plan, the City's overall per capita water use will be an important measure of progress and success in achieving the objectives of the City's water supply plan.

Table 10-1. City of Fresno Water Supply Plan Triggers and Corrective Action Guidelines

Stage	Triggers		Management and Administrative Actions	New Development Policies	Recharge Operation Actions	Water Conservation Actions	Recycled Water Operation Actions	Surface Water Operation Actions
	Net Groundwater Recharge	Per Capita Water Use						
1	If Net Groundwater Recharge is Below Goal by no more than 5%	If Per Capita Water Use is Above Goal by no more than 2%	• Advise Mayor and City Council by the end of February each year of groundwater balance status and per capita water use reduction for informational purposes		• Continue implementing plan components as planned			
2	If Net Groundwater Recharge is Below Goal by 5% to 15%	If Per Capita Water Use is Above Goal by 2% to 4%	• Advise Mayor and City Council by the end of February each year of groundwater balance status and per capita water use reduction and report on corrective actions being taken • Provide progress report to Mayor and City Council every six (6) months regarding corrective actions taken and their results		• Maximize recharge operations at existing recharge facilities through enhanced operations and maintenance	• Increase public outreach existing water conservation measures	• Accelerate activation of Copper River WRF and/or improvements to the RWRF to increase recycled water use in the City	• Accelerate completion of Northeast SWTF improvements to maximize treatment capacity • Use all other available surface water supplies for intentional groundwater recharge
3	If Net Groundwater Recharge is Below Goal by 15% to 25%	If Per Capita Water Use is Above Goal by 4% to 6%	• Advise Mayor and City Council by the end of February each year of groundwater balance status and per capita water use reduction and report on corrective actions being taken • Provide progress report to Mayor and City Council every three (3) months regarding corrective actions taken and their results	• Require new development to offset their projected outdoor potable water demands (e.g., use recycled water for all outdoor demands, convert existing potable water uses in the City to recycled water, participate in City water conservation programs to reduce potable water use)	• Maximize recharge operations at existing recharge facilities through enhanced operations and maintenance • Accelerate acquisition of new properties for development of new recharge basins	• Increase public outreach existing water conservation measures • Accelerate implementation of one or more planned new water conservation programs (primarily those related to outdoor water use)		
4	If Net Groundwater Recharge is Below Goal by 25% or more	If Per Capita Water Use is Above Goal by more than 6%	• Advise Mayor and City Council by the end of February each year of groundwater balance status and per capita water use reduction and report on corrective actions being taken • Provide progress report to Mayor and City Council every three (3) months regarding corrective actions taken and their results	• Require new development to offset 100% of their potable water demands (all indoor and outdoor potable water demand) (e.g., use recycled water for all outdoor demands, convert existing potable water uses in the City to recycled water, participate in City water conservation programs to reduce potable water use)	• Maximize recharge operations at existing recharge facilities through enhanced operations and maintenance • Accelerate acquisition of new properties for development of new recharge basins	• Increase public outreach existing water conservation measures • Accelerate implementation of one or more planned new water conservation programs (primarily those related to outdoor water use) • Implement a tiered water rate structure to further encourage water conservation		

Calculation of Overall Per Capita Water Use

The City's overall per capita water use should be calculated at the beginning of each calendar year for the previous calendar year by dividing the City's total potable water production (including all treated surface water produced and groundwater pumped for municipal and industrial uses) by the total estimated service area population.

The City's overall per capita water use for 2009 was calculated as follows:

2009 Overall Per Capita Water Use =

Total Treated Surface Water (19,563 acre-feet)

+ Total Groundwater Pumpage (138,254 acre-feet)

÷ Total Estimated Service Area Population in January 2009 (512,207 people)

= 275 gallons per capita per day (gpcd)

It should be noted that recycled water use, when available, should not be included in the calculation of overall per capita water use. Recycled water is a non-potable water supply which will offset the use of potable water supplies and help to reduce overall per capita water use in the City.

Summary of Objectives

As described in Chapter 4, one of the key objectives of the City's water supply plan is to reduce the City's overall per capita water use. Overall per capita water use within the City's service area is currently about 275 gallons per capita per day (gpcd) (based on 2009 data). The City's goal is to reduce and sustain an overall per capita water use of 243 gpcd by 2020. The City's historical per capita water use is shown on Figure 10-2, along with the per capita water use goals for the future.

As shown on Figure 10-2, the reduction in overall per capita water use to 243 gpcd by 2020 would be a 22 percent reduction from the City's SB X7-7 baseline per capita water use from 1996 to 2005. As discussed in Chapter 2, this reduction would be consistent with, and would actually slightly exceed, the requirements of the SB X7-7 legislation which passed in October 2009 and which calls for a 20 percent reduction in per capita water use statewide.

Recommended Means to Achieve Objectives

The primary means recommended to reduce overall per capita water use are the implementation of the City's on-going residential water meter installation program and the implementation of additional water conservation measures. The residential water metering program is scheduled to be completed by March 2013, and is anticipated to reduce residential demands by approximately 10 percent. Additional water conservation measures are also proposed to be implemented and reduce water demands by an additional 5 percent by 2010 and another 5 percent (for a total of 10 percent) by 2020.

Anticipated Trends and Results

The biggest decline in overall per capita water use is anticipated to occur as a result of the City's on-going residential water meter installation program scheduled to be completed by March 2013. As described in Chapter 4, it has been assumed that the 10 percent decrease resulting from the complete metering of all residential water customers would occur gradually, and would not be fully achieved until all of the meters were installed and all accounts were converted to a metered rate. Per the current metering program schedule, all of the City's water customers should be metered and billed on a metered water rate by March 2013, which should result in a water use reduction of about 10 percent among the residential customers by mid-2013.

As described in Chapter 4, the water conservation measures which are anticipated to have the most impact are those related to outdoor water use, specifically those related to reducing water used for landscape irrigation during the summer months (May through September). Examples of such water conservation measures include the following:

- Xeriscape Landscape Rebate for New Homes;
- Programmable Irrigation Controller Rebate;
- Weather-Based Irrigation Controller Rebate;
- Turf Replacement Rebate ("Cash for Grass"); and
- Landscape Water Audit and Budget Program.

Additional water conservation measures are proposed to reduce water demands by an additional 5 percent by 2010 and another 5 percent (for a total of 10 percent) by 2020.

Tracking Tool

Table 10-B, included at the end of this chapter, provides a spreadsheet to track the City's per capita water use. Annual water use statistics should be input into the Table 10-B spreadsheet as follows:

- Column 2: Total Annual Water Production in acre-feet

The calculation of the City's per capita water use is provided in Column 4 based on the City's estimate of its service area population (which assumes an annual population increase of 1.9 percent). It should be noted that if a different method is used to determine the service area population, the per capita water use may be different from that calculated in Column 4. Columns 5 and 6 of Table 10-B are provided for this alternative calculation of the per capita water use, if needed. Column 7 provides the per capita water use goal, and Column 9 provides the percent variance from that goal. The percent variance from the goal is then used to determine appropriate corrective actions, if needed. Potential corrective actions are described in Table 10-1.

RESIDENTIAL WATER METERING PROGRAM

Summary of Objectives

The City's residential water metering program is a critical component of the City's water supply plan. It is estimated that water demands will be reduced by 10 percent as a result of the residential water metering program. The metering program consists of the installation of approximately 105,000 residential water meters throughout the City and the subsequent conversion of those residential water accounts from a flat water rate to a metered water rate. Meter installation is scheduled to begin in mid 2010 and be completed by March 2013, to be in compliance with AB 514. Conversion of the residential accounts from a flat water rate to a metered water rate will begin in 2010 as connections are metered. The conversion of the residential customers to a metered water rate is the key point at which residential water use should decrease, as residential customers become aware of their actual water use and are billed based on their actual water use.

Anticipated Trends and Results

As shown on Figure 10-3, assuming that meter installation begins in July 2010, approximately 3,300 meters will need to be installed each month to meet the March 2013 deadline. Conversion of the residential accounts from a flat water rate to a metered water rate will begin in 2010, and may lag somewhat behind the meter installations due to administrative procedures and changes in customer billing cycles (e.g., under the current flat water rate billing system, customers are billed a flat rate at the beginning of each billing cycle, while metered water rate customers will be billed at the end of each billing cycle based on actual metered water use during the billing period). However, as described above, conversion to a metered water rate is a key part of the program, and should track closely behind the meter installations.

Tracking Tool

Table 10-C, included at the end of this chapter, provides a spreadsheet to track the City's progress on the residential water metering program. Monthly progress should be input into the spreadsheet as follows:

- Column 4: Number of Residential Water Meters Installed Each Month
- Column 6: Number of Residential Accounts Converted to Metered Water Rate Schedule Each Month

If meter installations begin to fall behind that required to meet the program deadline, additional meter installation crews may need to be added to increase the number of monthly meter installations. Likewise, if conversions of the metered residential accounts from a flat water rate to a metered water rate begin to fall behind meter installations, additional administrative and billing personnel may need to be added to assist with the billing conversions. The City should continuously monitor the progress of the residential water metering program to ensure that adequate progress is being made to meet the March 2013 deadline.

RECOMMENDED CORRECTIVE ACTIONS

Table 10-1 presents the proposed triggers and corrective actions for the City's water supply plan should progress in the areas described above fall behind established objectives and goals. As shown, the triggers and corrective actions are split into four stages, similar to the City's Water Shortage Contingency Plan.

Figure 10-1. City of Fresno Tracking of Groundwater Balance Status

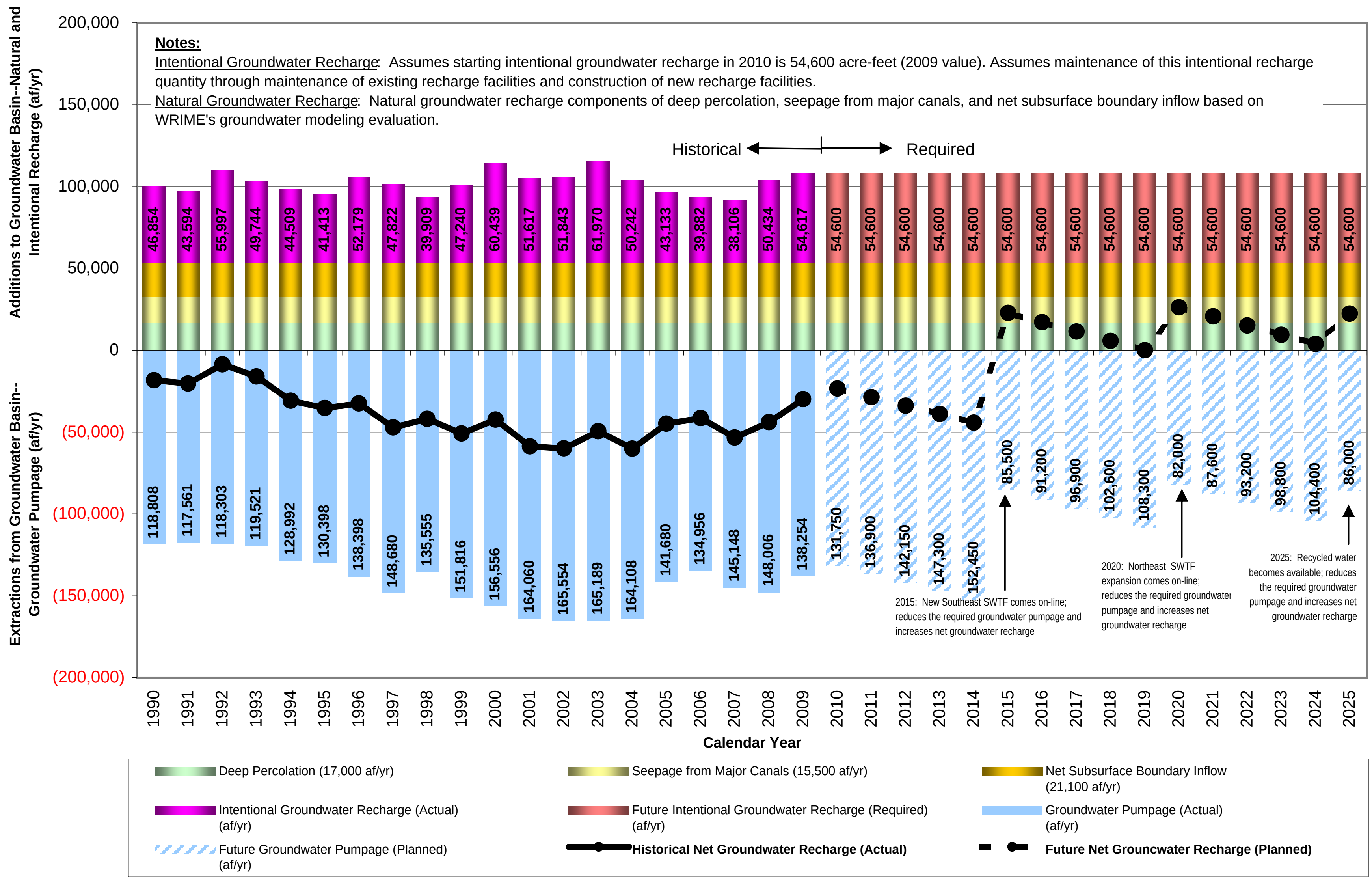

Figure 10-2. City of Fresno Historical Per Capita Water Use vs. Future Per Capita Water Use Goals

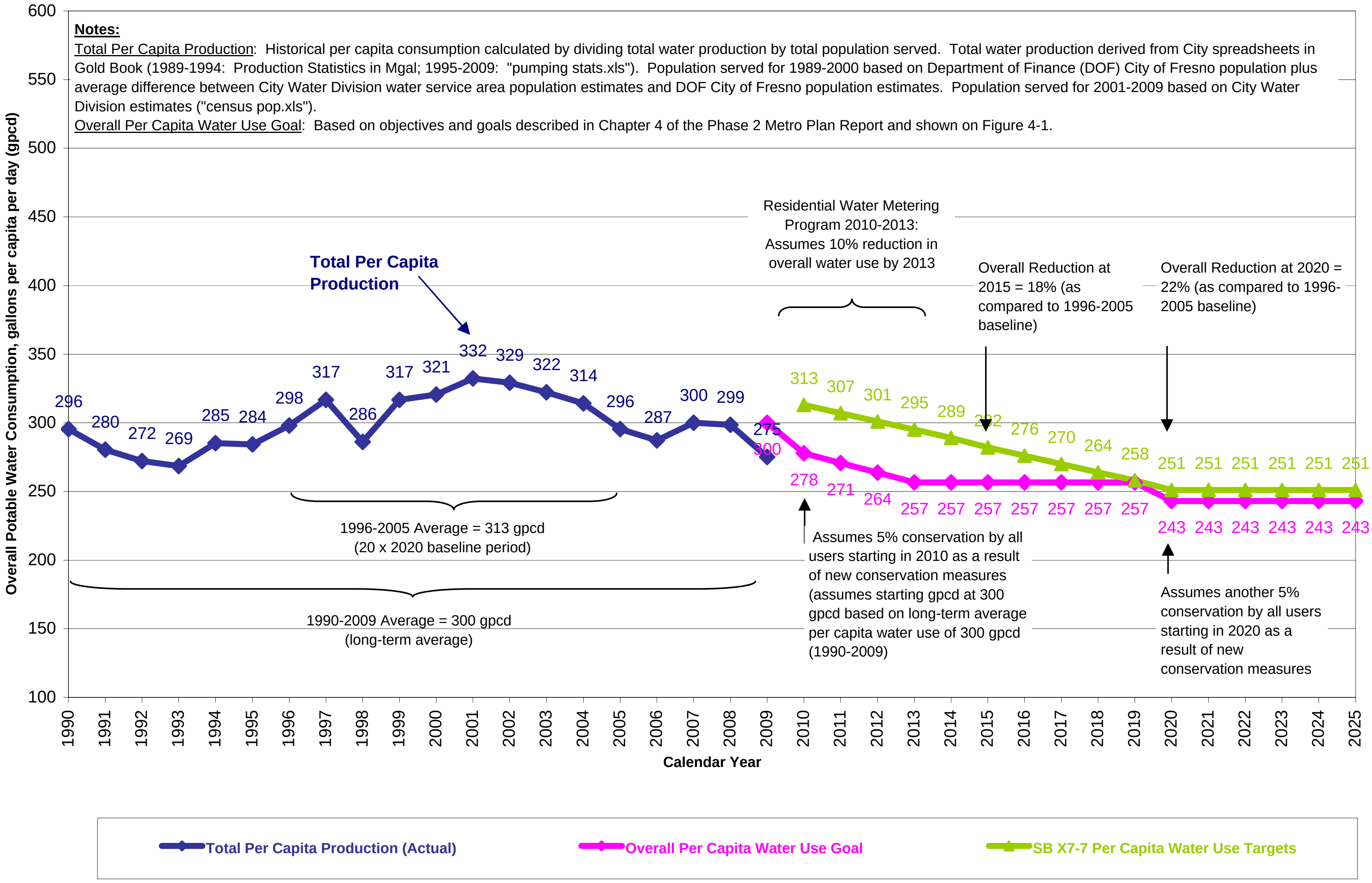

Figure 10-3. City of Fresno Residential Water Metering Program Goals vs. Actuals

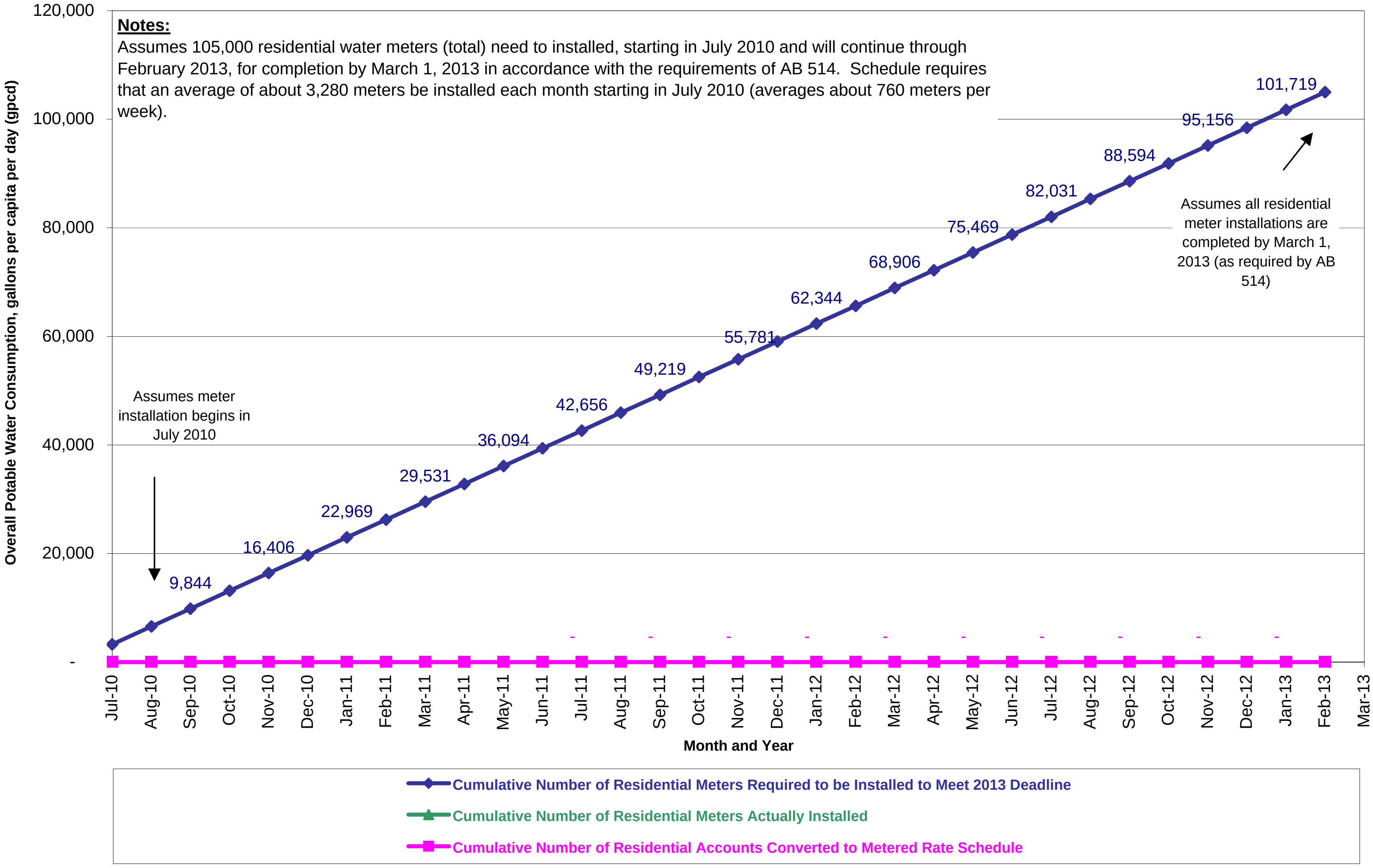

Table 10-A. City of Fresno Metro Plan Update Tracking of Net Groundwater Recharge and Key Contributing Factors

[1] Calendar Year	[2] Per WRIME Groundwater Modeling Evaluation — Natural Groundwater Recharge: Deep Percolation (17,000 af/yr)	[3] Per WRIME Groundwater Modeling Evaluation — Natural Groundwater Recharge: Seepage from Major Canals (15,500 af/yr)	[4] Per WRIME Groundwater Modeling Evaluation — Natural Groundwater Recharge: Net Subsurface Boundary Inflow (21,100 af/yr)	[5] Actual Intentional Recharge to be Input Each Year — Intentional Groundwater Recharge (Actual) (af/yr)	[6] Per Metro Plan Update — Future Intentional Groundwater Recharge (Required) (af/yr)	[7] Actual Groundwater Pumpage to be Input Each Year — Groundwater Pumpage (Actual) (af/yr)	[8] Per Metro Plan Update — Future Groundwater Pumpage (Planned) (af/yr)	[9] Column [2] + Column [3] + Column [4] + Column [5] - Column [7] — Net Groundwater Recharge (Actual) (af/yr)	[10] Per Metro Plan Update — Net Groundwater Recharge Goal (af/yr)	[11] Column [9] - Column [10] — Variance (af/yr)	[12] Column [11] divided by Column [10] — Percent Variance, %
1990	17,000	15,500	21,100	46,854		118,808		(18,354)			
1991	17,000	15,500	21,100	43,594		117,561		(20,367)			
1992	17,000	15,500	21,100	55,997		118,303		(8,706)			
1993	17,000	15,500	21,100	49,744		119,521		(16,177)			
1994	17,000	15,500	21,100	44,509		128,992		(30,883)			
1995	17,000	15,500	21,100	41,413		130,398		(35,385)			
1996	17,000	15,500	21,100	52,179		138,398		(32,619)			
1997	17,000	15,500	21,100	47,822		148,680		(47,258)			
1998	17,000	15,500	21,100	39,909		135,555		(42,046)			
1999	17,000	15,500	21,100	47,240		151,816		(50,976)			
2000	17,000	15,500	21,100	60,439		156,556		(42,517)			
2001	17,000	15,500	21,100	51,617		164,060		(58,843)			
2002	17,000	15,500	21,100	51,843		165,554		(60,111)			
2003	17,000	15,500	21,100	61,970		165,189		(49,619)			
2004	17,000	15,500	21,100	50,242		164,108		(60,266)			
2005	17,000	15,500	21,100	43,133		141,680		(44,947)			
2006	17,000	15,500	21,100	39,882		134,956		(41,474)			
2007	17,000	15,500	21,100	38,106		145,148		(53,442)			
2008	17,000	15,500	21,100	50,434		148,006		(43,972)			
2009	17,000	15,500	21,100	54,617		138,254		(30,037)			
2010	17,000	15,500	21,100		54,600		131,750		(23,550)	23,550	100%
2011	17,000	15,500	21,100		54,600		136,900		(28,700)	28,700	100%
2012	17,000	15,500	21,100		54,600		142,150		(33,950)	33,950	100%
2013	17,000	15,500	21,100		54,600		147,300		(39,100)	39,100	100%
2014	17,000	15,500	21,100		54,600		152,450		(44,250)	44,250	100%
2015	17,000	15,500	21,100		54,600		85,500		22,700	(22,700)	100%
2016	17,000	15,500	21,100		54,600		91,200		17,000	(17,000)	100%
2017	17,000	15,500	21,100		54,600		96,900		11,300	(11,300)	100%
2018	17,000	15,500	21,100		54,600		102,600		5,600	(5,600)	100%
2019	17,000	15,500	21,100		54,600		108,300		(100)	100	100%
2020	17,000	15,500	21,100		54,600		82,000		26,200	(26,200)	100%
2021	17,000	15,500	21,100		54,600		87,600		20,600	(20,600)	100%
2022	17,000	15,500	21,100		54,600		93,200		15,000	(15,000)	100%
2023	17,000	15,500	21,100		54,600		98,800		9,400	(9,400)	100%
2024	17,000	15,500	21,100		54,600		104,400		3,800	(3,800)	100%
2025	17,000	15,500	21,100		54,600		86,000		22,200	(22,200)	100%

[13] Calendar Year	[14] Per Metro Plan Update — Projected Demand (af/yr)	[15] Actual Demand to be Input Each Year — Actual Demand (af/yr)	[16] Column [15] - Column [14] — Variance (af/yr)	[17] Column [16] divided by Column [14] — Percent Variance, %	[18] Per Metro Plan Update — Projected Recycled Water Use (af/yr)	[19] Actual Recycled Water Use to be Input Each Year — Actual Recycled Water Use (af/yr)	[20] Column [19] - Column [18] — Variance (af/yr)	[21] Column [20] divided by Column [18] — Percent Variance, %	[22] Per Metro Plan Update — Projected Treated Surface Water Use (af/yr)	[23] Actual Treated Surface Water Use to be Input Each Year — Actual Treated Surface Water Use (af/yr)	[24] Column [23] - Column [22] — Variance (af/yr)
1990		118,808									
1991		117,562									
1992		118,303									
1993		119,521									
1994		128,992									
1995		130,389									
1996		138,389									
1997		148,670									
1998		135,546									
1999		151,806									
2000		156,487									
2001		164,049									
2002		165,542									
2003		165,177									
2004		164,108									
2005		157,278								15,598	
2006		155,750								20,794	
2007		165,798								20,650	
2008		168,122								20,116	
2009		157,817								19,563	
2010	163,300		(163,300)	-100%	750		(750)	-100%	30,800		(30,800)
2011	168,500		(168,500)	-100%	800		(800)	-100%	30,800		(30,800)
2012	173,800		(173,800)	-100%	850		(850)	-100%	30,800		(30,800)
2013	179,000		(179,000)	-100%	900		(900)	-100%	30,800		(30,800)
2014	184,200		(184,200)	-100%	950		(950)	-100%	30,800		(30,800)
2015	189,300		(189,300)	-100%	1,000		(1,000)	-100%	102,800		(102,800)
2016	195,000		(195,000)	-100%	1,000		(1,000)	-100%	102,800		(102,800)
2017	200,700		(200,700)	-100%	1,000		(1,000)	-100%	102,800		(102,800)
2018	206,400		(206,400)	-100%	1,000		(1,000)	-100%	102,800		(102,800)
2019	212,100		(212,100)	-100%	1,000		(1,000)	-100%	102,800		(102,800)
2020	206,400		(206,400)	-100%	1,000		(1,000)	-100%	123,400		(123,400)
2021	212,000		(212,000)	-100%	1,000		(1,000)	-100%	123,400		(123,400)
2022	217,600		(217,600)	-100%	1,000		(1,000)	-100%	123,400		(123,400)
2023	223,200		(223,200)	-100%	1,000		(1,000)	-100%	123,400		(123,400)
2024	228,800		(228,800)	-100%	1,000		(1,000)	-100%	123,400		(123,400)
2025	234,400		(234,400)	-100%	25,000		(25,000)	-100%	123,400		(123,400)

Table 10-B. City of Fresno Metro Plan Update Tracking of Per Capita Water Use

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
	Actual Production Data to be Input Each Year		Column [2] divided by Column [3]		Column [2] divided by Column [5]		Column [4] minus Column [7]	Column [8] divided by Column [7]
Calendar Year	**Total Annual Water Production (Actual) (af/yr)**	**Estimated Service Area Population (based on 1.9% increase each year)**	**Calculated Per Capita Water Use based on Estimated Population, gpcd**	**Actual Service Area Population**	**Calculated Per Capita Water Use based on Actual Population, gpcd**	**Per Capita Water Use Goal, gpcd**	**Variance, gpcd**	**Percent Variance, %**
1990	118,808	358,862	296					
1991	117,561	374,362	280					
1992	118,303	388,062	272					
1993	119,521	397,362	269					
1994	128,992	403,862	285					
1995	130,398	409,562	284					
1996	138,398	414,562	298					
1997	148,680	419,062	317					
1998	135,555	422,862	286					
1999	151,816	427,962	317					
2000	156,498	435,814	321					
2001	164,060	440,608	332					
2002	165,554	448,980	329					
2003	165,189	457,511	322					
2004	164,108	466,203	314					
2005	157,278	475,061	296					
2006	155,750	484,087	287					
2007	165,798	493,285	300					
2008	168,122	502,657	299					
2009	157,817	512,207	275	512,207	275	300	(25)	-8%
2010		521,939	-	521,939	0	278	(278)	-100%
2011		531,856	-	531,856	0	271	(271)	-100%
2012		541,962	-	541,962	0	264	(264)	-100%
2013		552,259	-	552,259	0	257	(257)	-100%
2014		562,752	-	562,752	0	257	(257)	-100%
2015		573,444	-	573,444	0	257	(257)	-100%
2016		584,339	-	584,339	0	257	(257)	-100%
2017		595,442	-	595,442	0	257	(257)	-100%
2018		606,755	-	606,755	0	257	(257)	-100%
2019		618,284	-	618,284	0	257	(257)	-100%
2020		630,031	-	630,031	0	243	(243)	-100%
2021		642,002	-	642,002	0	243	(243)	-100%
2022		654,200	-	654,200	0	243	(243)	-100%
2023		666,629	-	666,629	0	243	(243)	-100%
2024		679,295	-	679,295	0	243	(243)	-100%
2025		692,202	-	692,202	0	243	(243)	-100%

Table 10-C. City of Fresno Metro Plan Update Tracking of Residential Water Metering Program

[1]	[2]	[3]	[4]	[5]	[6]	[7]
		Cumulative Sum of Column [2]	Sample Data for Illustrative Purposes--Actual Data to be Input Monthly	Cumulative Sum of Column [4]	Sample Data for Illustrative Purposes--Actual Data to be Input Monthly	Cumulative Sum of Column [6]
Month and Year	**Number of Meters to be Installed**	**Cumulative Number of Residential Meters Required to be Installed to Meet 2013 Deadline**	**Actual Number of Meters Installed**	**Cumulative Number of Residential Meters Actually to be Installed**	**Number of Residential Accounts Converted to Metered Rate Schedule**	**Cumulative Number of Residential Accounts Converted to Metered Rate Schedule**
Jul-10	3,281	3,281		-		-
Aug-10	3,281	6,563		-		-
Sep-10	3,281	9,844		-		-
Oct-10	3,281	13,125		-		-
Nov-10	3,281	16,406		-		-
Dec-10	3,281	19,688		-		-
Jan-11	3,281	22,969		-		-
Feb-11	3,281	26,250		-		-
Mar-11	3,281	29,531		-		-
Apr-11	3,281	32,813		-		-
May-11	3,281	36,094		-		-
Jun-11	3,281	39,375		-		-
Jul-11	3,281	42,656		-		-
Aug-11	3,281	45,938		-		-
Sep-11	3,281	49,219		-		-
Oct-11	3,281	52,500		-		-
Nov-11	3,281	55,781		-		-
Dec-11	3,281	59,063		-		-
Jan-12	3,281	62,344		-		-
Feb-12	3,281	65,625		-		-
Mar-12	3,281	68,906		-		-
Apr-12	3,281	72,188		-		-
May-12	3,281	75,469		-		-
Jun-12	3,281	78,750		-		-
Jul-12	3,281	82,031		-		-
Aug-12	3,281	85,313		-		-
Sep-12	3,281	88,594		-		-
Oct-12	3,281	91,875		-		-
Nov-12	3,281	95,156		-		-
Dec-12	3,281	98,438		-		-
Jan-13	3,281	101,719		-		-
Feb-13	3,281	105,000		-		-
Mar-13						
Apr-13						
May-13						
Jun-13						
Total	105,000		-		-	