TURLOCK IRRIGATION DISTRICT

2012 AGRICULTURAL WATER MANAGEMENT PLAN

Prepared by:

Turlock Irrigation District
333 E. Canal Drive
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DECEMBER 2012

Prepared for compliance with:

Part 2.8 of Division 6 of the Water Code, pertaining to Agricultural Water Management Planning (Senate Bill SBx7-7, the Water Conservation Act of 2009)

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Preface

This Agricultural Water Management Plan (AWMP or Plan) has been prepared by Turlock Irrigation District (TID or District) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7). SBx7-7 modifies Division 6 of the California Water Code (CWC or Code), adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800). In particular, SBx7-7 requires all agricultural water suppliers to prepare and adopt an AWMP as set forth in the CWC and the California Code of Regulations (CCR) on or before December 31, 2012. The Plan must be updated by December 31, 2015 and then every 5 years thereafter (§10820 (a)). Additionally, the CWC requires suppliers to implement certain efficient water management practices (EWMPs).

To develop and adopt this Plan by the December 31, 2012 deadline, the District initiated preparations in the spring of 2012, developed a project schedule and engaged technical consultants to assist with preparing the Plan. Working backwards from the December 31 deadline, the District scheduled Plan adoption by the Board of Directors at the December 11 meeting. This was the latest schedule possible that would allow time to revise the Plan, if needed, in response to public comment. To allow time for public review of the draft Plan prior to the public hearing and proposed adoption in mid-December, the final draft of the Plan had to be complete by mid-November. To ensure the draft final Plan was complete by mid-November, all Plan sections were drafted by the beginning of September.

In contrast to this schedule, the draft Department of Water Resources (DWR) Guidebook to Assist Agricultural Water Suppliers to prepare a 2012 Agricultural Water Management Plan (Guidebook) underwent significant revisions in September and October 2012 with the final version released in November. Thus, the final Guidebook was not available as a reference for preparation of this 2012 Plan. The main resources used to develop this 2012 Plan were the CWC itself, the relevant sections of the CCR, and the January 12, 2012 version of the Guidebook. The DWR Guidebook will be referenced during preparation of the 2015 Plan.

A cross-reference identifying the location(s) in the AWMP within which each of the applicable requirements of SBx7-7 and the corresponding sections of the CWC and CCR is addressed is provided on the following pages. This cross-reference is intended to support efficient review of the AWMP to verify compliance with the Law

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Cross-Reference of Relevant Sections of the California Water Code to Turlock Irrigation District 2012 Agricultural Water Management Plan

California Water Code, Division 6, Part 2.55. Sustainable Water Use and Demand Reduction

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
Chapter 4. Agricultural Water Suppliers				
10608.48	(a)		On or before July 31, 2012, an agricultural water supplier shall implement efficient water management practices pursuant to subdivisions (b) and (c).	**6**
	(b)		Agricultural water suppliers shall implement all of the following critical efficient management practices:	(see below)
		(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement paragraph (2)	**2.6, 6.2, App. F**
		(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	**2.7, 6.3**
	(c)		Agricultural water suppliers shall implement additional efficient management practices, including, but not limited to, practices to accomplish all of the following, if the measures are locally cost effective and technically feasible:	(see below)
		(1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	**6.4.1, 6.5, 6.6**
		(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils.	**3.3, 6.4.2, 6.5, 6.6**
		(3)	Facilitate the financing of capital improvements for on-farm irrigation systems.	**6.4.3, 6.5, 6.6**
		(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at the farm level. (B) Conjunctive use of groundwater. (C) Appropriate increase of groundwater recharge. (D) Reduction in problem drainage. (E) Improved management of environmental resources. (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	**2.7, 6.4.4, 6.5, 6.6**
		(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage.	**2.2, 6.4.5, 6.5, 6.6**
		(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	**2.2, 6.4.6, 6.5, 6.6**
		(7)	Construct and operate supplier spill and tailwater recovery systems.	**2.2, 6.4.7, 6.5, 6.6**
		(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	**2.7, 3, 4, 5, 6.4.8, 6.5, 6.6, App. B**
		(9)	Automate canal control structures.	**6.4.9, 6.5, 6.6**
		(10)	Facilitate or promote customer pump testing and evaluation.	**6.4.10, 6.5, 6.6**
		(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports.	**6.4.11, 6.5, 6.6**
		(12)	Provide for the availability of water management services to water users. These services may include, but are not limited to, all of the following: (A) On-farm irrigation and drainage system evaluations. (B) Normal year and real-time irrigation scheduling and crop evapotranspiration information. (C) Surface water, groundwater, and drainage water quantity and quality data. (D) Agricultural water management educational programs and materials for farmers, staff, and the public.	**6.4.12, 6.5, 6.6, App. C**
		(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	**6.4.13, 6.5, 6.6**
		(14)	Evaluate and improve the efficiencies of the supplier's pumps.	**6.4.13, 6.5, 6.6**
10608.48	(d)		Agricultural water suppliers shall include in the agricultural water management plans required pursuant to Part 2.8 (commencing with Section 10800) a report on which efficient water management practices have been implemented and are planned to be implemented, an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future. If an agricultural water supplier determines that an efficient water management practice is not locally cost effective or technically feasible, the supplier shall submit information documenting that determination.	**6**

California Water Code, Division 6, Part 2.8. Agricultural Water Management Planning

Chapter 3. Agricultural Water Management Plans

Article 1. General Provisions

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10820	(a)		An agricultural water supplier shall prepare and adopt an agricultural water management plan in the manner set forth in this chapter on or before December 31, 2012, and shall update that plan on December 31, 2015, and on or before December 31 every five years thereafter.	**1, App. A**
10821	(a)		An agricultural water supplier required to prepare a plan pursuant to this part shall notify each city or county within which the supplier provides water supplies that the agricultural water supplier will be preparing the plan or reviewing the plan and considering amendments or changes to the plan. The agricultural water supplier may consult with, and obtain comments from, each city or county that receives notice pursuant to this subdivision.	**1, App. A**
	(b)		The amendments to, or changes in, the plan shall be adopted and submitted in the manner set forth in Article 3 (commencing with Section 10840).	**1, App. A**

Article 2. Contents of Plans

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10826			An agricultural water management plan shall be adopted in accordance with this chapter. The plan shall do all of the following:	(see below)
	(a)		Describe the agricultural water supplier and the service area, including all of the following:	(see below)
		(1)	Size of the service area.	**2.1**
		(2)	Location of the service area and its water management facilities.	**2.2, App. D**
		(3)	Terrain and soils.	**2.3**
		(4)	Climate.	**2.4**
		(5)	Operating rules and regulations.	**2.5, App. D**
		(6)	Water delivery measurements or calculations.	**2.6, 6.2, App. F**
		(7)	Water rate schedules and billing.	**2.7, 6.3**
		(8)	Water shortage allocation policies.	**2.5, 2.8**
10826	(b)		Describe the quantity and quality of water resources of the agricultural water supplier, including all of the following:	(see below)
		(1)	Surface water supply.	**2.2, 3, 4**
		(2)	Groundwater supply.	**2.2, 3, 4, App. B**
		(3)	Other water supplies.	**3, 4**
		(4)	Source water quality monitoring practices.	**3.4**
		(5)	Water uses within the agricultural water supplier's service area, including all of the following: (A) Agricultural. (B) Environmental. (C) Recreational. (D) Municipal and industrial. (E) Groundwater recharge. (F) Transfers and exchanges. (G) Other water uses.	**3, 4**
		(6)	Drainage from the water supplier's service area.	**4**
10826	(b)	(7)	Water accounting, including all of the following: (A) Quantifying the water supplier's water supplies. (B) Tabulating water uses. (C) Overall water budget.	**4**
		(8)	Water supply reliability.	**3, 4**
	(c)		Include an analysis, based on available information, of the effect of climate change on future water supplies.	**5**
	(d)		Describe previous water management activities.	**1.1, 2, 3, 6**
	(e)		Include in the plan the water use efficiency information required pursuant to Section 10608.48.	**6**

Article 3. Adoption and Implementation of Plans				
Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10841			Prior to adopting a plan, the agricultural water supplier shall make the proposed plan available for public inspection, and shall hold a public hearing on the plan. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned agricultural water supplier pursuant to Section 6066 of the Government Code. A privately owned agricultural water supplier shall provide an equivalent notice within its service area and shall provide a reasonably equivalent opportunity that would otherwise be afforded through a public hearing process for interested parties to provide input on the plan. After the hearing, the plan shall be adopted as prepared or as modified during or after the hearing.	**1, App. A**
10842			An agricultural water supplier shall implement the plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan, as determined by the governing body of the agricultural water supplier.	**1.3.1, 7, 8**
10843	(a)		An agricultural water supplier shall submit to the entities identified in subdivision (b) a copy of its plan no later than 30 days after the adoption of the plan. Copies of amendments or changes to the plans shall be submitted to the entities identified in subdivision (b) within 30 days after the adoption of the amendments or changes.	**1, App. A**
	(b)		An agricultural water supplier shall submit a copy of its plan and amendments or changes to the plan to each of the following entities:	(see below)
		(1)	The Department of Water Resources (DWR).	**1, App. A**
		(2)	Any city, county, or city and county within which the agricultural water supplier provides water supplies.	**1, App. A**
		(3)	Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies.	**1, App. A**
		(4)	Any urban water supplier within which jurisdiction the agricultural water supplier provides water supplies.	**1, App. A**
		(5)	Any city or county library within which jurisdiction the agricultural water supplier provides water supplies.	**1, App. A**
		(6)	The California State Library.	**1, App. A**
		(7)	Any local agency formation commission serving a county within which the agricultural water supplier provides water supplies.	**1, App. A**
10844	(a)		Not later than 30 days after the date of adopting its plan, the agricultural water supplier shall make the plan available for public review on the agricultural water supplier's Internet Web site.	**1, App. A**
	(b)		An agricultural water supplier that does not have an Internet Web site shall submit to DWR, not later than 30 days after the date of adopting its plan, a copy of the adopted plan in an electronic format. DWR shall make the plan available for public review on DWR's Internet Web site.	**Not Applicable**

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List of Acronyms

ACOE ... Army Corps of Engineers
ACWA ... Association of California Water Agencies
AF ... acre-feet
ASCE ... American Society of Civil Engineers
AWMC ... Agricultural Water Management Council
AWMP ... Agricultural Water Management Plan
CASGEM ... California Statewide Groundwater Elevation Monitoring
cfs ... cubic feet per second
CIMIS ... California Irrigation Management Information System
CMUA ... California Municipal Utilities Association
CWC ... California Water Code
CCR ... California Code of Regulations
CCUF ... Crop Consumptive Use Fraction
DF ... Delivery Fraction
DO ... Dissolved Oxygen
DWR ... Department of Water Resources
EC ... Electrical Conductivity
EIR ... Environmental Impact Report
ESJWQC ... East San Joaquin Water Quality Coalition
ET ... Evapotranspiration
ET_{aw} ... Evapotranspiration of applied water
ET_c ... Crop evapotranspiration
ET_o ... Reference evapotranspiration
EWMP ... Efficient Water Management Practice
FERC ... Federal Energy Regulatory Commission
GCMs ... Global Climate Models
GWMP ... Groundwater Management Plan
ID ... Improvement District
ILRP ... Irrigated Lands Regulatory Program
ITRC ... Irrigation Training and Research Center
LGA ... Local Groundwater Assistance

M&I .... Municipal and Industrial
MID .... Modesto Irrigation District
MOU .... Memorandum of Understanding
NPDES .... National Pollutant Discharge Elimination System
ppm .... parts per million
SBx7-7 .... Water Conservation Act of 2009
SCADA .... Supervisory Control and Data Acquisition
SWRCB .... State Water Resources Control Board
TDS .... Total Dissolved Solids
TGBA .... Turlock Groundwater Basin Association
TID .... Turlock Irrigation District
TKN .... Total Kjeldahl Nitrogen
TOC .... Total Organic Carbon
USBR .... United States Bureau of Reclamation
USCID .... United States Committee for Irrigation and Drainage
VAMP .... Vernalis Adaptive Management Plan
WDO .... Water Distribution Operator
WDR .... Waste Discharge Requirements
WMF .... Water Management Fraction
WUE .... Water Use Efficiency

Glossary of Terms

Acre-Foot…………………………The volume of water required to cover one acre of land one foot deep. Equal to 325,900 gallons.

Assessed Acres…………………...Total acres, as determined by the county assessor's office, for parcels that receive irrigation water. This acreage includes developed (non-irrigated) portions of the parcels such as roads, buildings and ditches.

Conjunctive Use …………………Using a combination of surface water and groundwater supplies to meet water demands.

Conjunctive Management ………Coordinating operation and monitoring of surface water and groundwater supplies to meet defined objectives.

Evapotranspiration………………The loss of water, to the atmosphere, by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).

Garden Head……………………..A parcel of land that is five acres or less in size and receives irrigation water.

Gross Acres ………………………All lands within the irrigation service boundary such as cities, agricultural lands, roads and lake acreage.

Improvement District…….……...An Improvement District (ID) is a mechanism that allows a group of growers to pool resources to construct irrigation facilities. IDs can be formed for a variety of reasons, such as constructing, operating, and maintaining ditches, pipes, and wells, as well as surface and subsurface drains. TID administers the improvement districts.

Irrigable Acres…………………...All lands that could be irrigated within the irrigation service boundary. This designation includes both lands that are currently irrigated and lands that are not currently being irrigated but have access to irrigation water through an active irrigation service connection.

Irrigated Acres…………………...An estimate of the actual amount of land surface to which irrigation water is being applied. A survey performed in the 1990's found that approximately six percent of assessed acres are non-productive lands such as roads, buildings and ditches. Therefore, the Assessed Acres have been reduced by six percent to arrive at the Irrigated Acres.

Supplemental Pumping…………Private groundwater pumping by growers used to supplement irrigation water supplied by TID.

Turlock Groundwater Basin……The groundwater basin underlying the eastern portion of the San Joaquin Valley bounded by the Tuolumne River to the north and the Merced River to the south. The western and eastern boundaries of the groundwater basin are the San Joaquin River and the Sierra Nevada foothills, respectively.

Executive Summary

INTRODUCTION

The Turlock Irrigation District's (TID) Agricultural Water Management Plan (AWMP or Plan) has been prepared to fulfill the requirements of the Water Conservation Act of 2009 (SBx7-7). In developing the Plan, TID has devoted considerable effort to evaluating water management and to developing a program aimed at sustaining sound water management practices where they are already in place and improving practices that can be strengthened.

TID understands that the intent of SBx7-7 is to encourage water suppliers to evaluate their water management operations and to implement locally cost-effective efficient water management practices (EWMPs) that improve the efficient use of irrigation water.

TID'S CONJUNCTIVE MANAGEMENT PERSPECTIVE

A key point highlighted by this AWMP is the District's reliance on both surface water and groundwater as sources of supply. The water balance developed as part of the AWMP shows that, on average, 84 to 88 percent (depending on water year type) of TID's water supply comes from surface sources with the remainder coming from groundwater[1]. The computations performed for the water balance and presented throughout the Plan are based on water usage during the period from 1991 through 2011. This period encompasses 13 years of normal water supplies and 8 years of reduced water supplies (as characterized based on annual allotments to growers), and illustrates how TID shifts between groundwater and surface water supply sources in response to hydrologic conditions. The District encourages the use of surface water for crop production when it is available to reduce reliance on groundwater and maintain long-term water supply reliability. As an example, during 2005, an above normal water year, 90 percent of the water delivered to irrigators came from surface supplies. By contrast, in the dry year of 2008, surface water utilization declined to 81 percent as a result of increased groundwater pumping by TID to supplement diminished inflow and storage in Don Pedro Reservoir.

Analysis also shows that seepage and deep percolation of a portion of TID's surface water supply serves as the primary source of recharge to the groundwater system. Thus, while groundwater provides a significant portion of the water used by the District and others within the Turlock Groundwater Basin, much of this groundwater is derived from management of surface water resources by TID and its irrigation customers. Because of the flexibility offered by access to both surface water and groundwater as sources of supply, TID will continue to pursue a deliberate course of conjunctive management.

While TID does not have spreading basins and other facilities dedicated to direct groundwater recharge, conjunctive management is promoted through its pricing policies and operating practices. These actions help support sustainable agricultural production within TID. In addition, the benefits of TID's conjunctive management policies extend to municipal users within the District and to agricultural users outside of TID's boundaries for whom groundwater

[1] The TID water supply includes Turlock Lake releases for irrigation, TID drainage well pumping, and TID rented well pumping. Other water supplies such as tailwater and recycled water are not included as they are minor sources and to avoid double counting of surface water supplies that are reused.

is the only source of supply. Even with these measures, groundwater levels continue to decline on the eastern side of the Turlock Basin, where surface water supplies are not available.

IMPLEMENTATION OF EFFICIENT WATER MANAGEMENT PRACTICES

The specific mechanisms for promoting improved water management under SBx7-7 are sixteen EWMPs. Of this total, two are critical or mandatory practices that are required of all water suppliers submitting AWMPs; the remaining fourteen are conditionally applicable practices subject to technical feasibility and local cost effectiveness. These conditionally applicable EWMPs must be implemented if they are found to be technically feasible and locally cost effective based on conditions within TID.

The TID AWMP evaluates and describes the extent to which TID currently implements each of the EWMPs and discusses how the EWMPs could be better implemented. Table ES.1 of this Executive Summary summarizes the status of EWMP implementation for each of the EWMPs. TID has implemented and continues to implement all technically feasible EWMPs at a locally cost-effective level.

CONCLUSION

Development of this AWMP has provided TID with an opportunity to examine its water management practices and to evaluate how these practices support the District's goal of providing a reliable, high quality, affordable water supply for its irrigation customers. The Plan demonstrates the critical importance of TID's overall conjunctive management strategy to provide a reliable and adequate water supply to its customers. As demonstrated in this Plan, the District is committed to ongoing evaluation and implementation of EWMPs at locally cost effective levels to support TID goals while complying with SBx7-7.

Table ES.1. TID's Efficient Water Management Practice Implementation Status.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical EWMPs – Mandatory				
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	Developed a water measurement corrective action plan (Appendix F) pursuant to 23 CCR §597.4(e)(4).	Implement corrective action plan (Appendix F) per budget and schedule.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	Completed the Proposition 218 process and adopted a new pricing structure based in part on quantity delivered in June 2012. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included.	Begin volumetric charges through application of the new pricing structure with the 2013 irrigation season.
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible				
10608.48.c(1)	Facilitate alternative land use for lands with exception-ally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring.	
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	1. M&I wastewater in Harding Drain recycled by TID for irrigation. 2. M&I wastewater used for cooling at TID's Walnut Energy Center. 3. M&I wastewater applied directly to TID irrigated lands. 4. Dairy nutrient water used by TID improvement districts for irrigation.	1. Continue existing use of recycled water within TID. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water.
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	1. Financing of on-farm improvement district irrigation facilities. 2. Engineering design and construction oversight for on-farm improvement district irrigation facilities. 3. At-cost maintenance and repair of on-farm improvement district irrigation facilities. 4. Interest-free deferral of maintenance, repair, and electrical charges. 5. Pursuit of grant funding for on-farm improvements.	1. Continue various financing activities to support development, operation, maintenance, and repair of on-farm irrigation systems.
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	1. Pricing structure promotes more efficient water use at the farm level, conjunctive use of groundwater, appropriate increase of groundwater recharge, prevention of problem drainage, and effective management of all water sources throughout the year.	1. Continue to implement tiered pricing structure to promote TID's water management goals.
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	1. Lined or converted to pipelines over 90 percent of its distribution system. 2. Lined an additional 4.5 miles of canals between 2006 and 2008. 3. Resurfaces more than 2 miles of lining each year. 4. Improvement district pipelines are actively maintained and replaced as necessary. 5. Evaluated regulating reservoirs (not locally cost-effective at this time).	1. Continue to resurface lining each year to maintain effectiveness. 2. Install new lining as appropriate based on local cost-effectiveness. 3. Continue active maintenance and repair of improvement district pipelines. 4. Continue to evaluate regulating reservoir opportunities

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Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	1. Implemented arranged demand delivery, providing a wide range of flexibility in irrigation frequency and duration, providing water with a lead time of approximately 2 days. 2. Moved its call center in 2008 to improve customer service. 3. Provides water use information to irrigators for their fields upon request and in an annual report. 4. Worked over time to accommodate changes in demand characteristics for micro irrigation systems. 5. Operators monitor the distribution system at 60 SCADA sites to enhance operational flexibility.	1. Continue to provide high levels of delivery flexibility and evaluate locally cost effective flexibility improvements. 2. Implement online delivery ordering and online availability of historical water use.
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	1. Intercepts spillage from upper laterals in the Ceres Main Canal. 2. Recovers operational spillage from Harding Drain. 3. Recovers and reuses tailwater re-entering the distribution system. 4. Implemented real time SCADA monitoring of spill sites. 5. Operates drainage wells throughout the system, providing added operational flexibility and localized supply that enables spillage prevention.	1. Continue various strategies and actions to recover and prevent spillage and tailwater. 2. Continue to evaluate and implement locally cost effective improvements to recover and prevent spillage and tailwater.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	1. Implemented a comprehensive conjunctive management program. 2. Operates over 100 drainage wells to increase water supply. 3. Rents up to 120 wells to supplement the available surface water supply. 4. Pricing structure promotes the following conjunctive management goals: (1) encourages use of available surface water supplies, (2) encourages conservation of limited surface water supplies in dry years, and (3) provides revenue required to operate drainage wells and rental wells in dry years. 5. Promotes direct and in-lieu recharge through surplus water sales outside of the service area. 6. Substitution of M&I wastewater for groundwater to provide cooling at Walnut Energy Center. 7. Adopted GWMP, and actively participates in local groundwater management activities. 8. Implementation of groundwater monitoring as part of CASGEM. 9. Development of sophisticated water models to support long term planning and management.	1. Continue various ongoing conjunctive management strategies and actions as part of TID's comprehensive conjunctive management program. 2. Continue to evaluate and implement locally cost effective actions.
10608.48.c(9)	Automate canal control structures	Implementing	1. Operates more than 330 automatic canal control structures. 2. Monitors 60 SCADA sites providing real time flow and water level information.	1. Continue to operate and maintain automatic control structures. 2. Continue real time SCADA monitoring. 3. Continue to evaluate and implement locally cost effective actions.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	1. Provides testing of private pumps upon request within its irrigation and electrical service areas. 2. Tests all rented private wells once per year. 3. Trained employees in pump efficiency testing.	1. Continue to provide testing of private pumps and to maintain in-house pump testing capability.

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Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	1. Designated a Water Conservation Coordinator in June 1997.	1. Continue to employ a designated Water Conservation Coordinator.
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	1. Provides engineering design services for improvement district facilities. 2. Provides private pump testing upon request. 3. Installed, rents land for, and maintains the Denair CIMIS site and provides a link to CIMIS on its web site. 4. Provides detailed water use information for individual fields to irrigators upon request, including a year-end water use report that is mailed to all irrigators. 5. Provides detailed information on the suitability of surface, ground, and drain water quality for irrigation upon request. 6. Provides real time hydrologic information on its website. 7. Distributes a grower newsletter multiple times per year, holds annual grower meetings, and organizes occasional seminars on various water management topics.	1. Continue to provide various water management services. 2. Continue to evaluate and implement locally cost effective services.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	1. Cooperates with the Modesto Irrigation District (MID), who co-owns Don Pedro Reservoir. 2. Coordinates with other agencies that have the potential to impact the District's flexibility in delivery and storage. 3. Is a member of the Turlock Basin Groundwater Association (TGBA).	1. Continue cooperation with MID and others to allow more flexible deliveries and storage. 2. Continue to evaluate and implement locally cost effective opportunities.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	1. Tests District owned and rented wells. 2. Trained employees in pump efficiency testing. 3. Established an ongoing capital improvement program to rehabilitate and replace pumps as necessary.	1. Continue to test TID pumps and to maintain in-house pump testing capability. 2. Continue ongoing rehabilitation and replacement of TID pumps as necessary.

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1 Plan Preparation

A critical component in the development of an Agricultural Water Management Plan (AWMP or Plan) is the solicitation of feedback from interested parties. This section describes TID's coordination with other agencies in the development of this AWMP, as well as TID's past water management activities.

1.1 PAST WATER MANAGEMENT ACTIVITIES

The Turlock Irrigation District (TID or District) was the first irrigation district formed in California under the Wright Act in June 1887, and is celebrating its 125th anniversary this year. Although the current Agricultural Water Management Planning requirements were recently established, water management planning is not a new concept for TID. The District continues to evaluate and implement new cost effective approaches and technologies as they become available, to ensure the District's water resources are managed to meet local water supply needs and environmental stewardship requirements now, and in the future.

TID was one of the first agencies in California to adopt a Groundwater Management Plan pursuant to Assembly Bill 3030, to sign on to the Memorandum of Understanding (MOU) establishing the Agricultural Water Management Council (AWMC), and to prepare an Agricultural Water Management Plan (AWMP) approved by the AWMC. TID's first AWMP was adopted in July 1999 and approved by the Ag Water Management Council in May 2001. Since that time, TID has implemented all locally cost effective and technically feasible Efficient Water Management Practices (EWMPs). Some of the most recent implementation efforts include:

- Automation of canal control structures,
- Improved measurement of canal and delivery flows,
- Installation of water quality monitoring telemetry,
- Additional lining of canals and other facility modifications to improve delivery reliability and operational flexibility,
- Improved water balance accounting,
- Installation and maintenance of a CIMIS station to provide more accurate local crop ET information to growers,
- Seepage testing to refine seepage calculations,
- Adoption of a volumetric pricing structure,
- Development of a plan to bring the District into compliance with delivery measurement requirements (pursuant to 23 CCR §597) within 3 years, and
- Continued implementation of numerous other measures to provide information to growers and to ensure water delivery reliability and flexibility.

1.2 AGENCY COORDINATION AND PUBLIC PARTICIPATION

Coordination with other agencies and public participation are critical components of the agricultural water management planning process. The following section describes the on-going coordination efforts between TID and the various local agencies in this region that manage water resources. Additionally, this section provides information on the public participation process used during the development, adoption, and implementation phases of the planning process.

1.2.1 Agency Coordination

TID holds joint water rights and ownership of Don Pedro Reservoir with the Modesto Irrigation District (MID). As such, the districts (TID and MID) continuously work together to coordinate and manage the shared resource. Additionally, TID maintains close relationships with irrigation districts on other tributaries of the San Joaquin River, and through those relationships is able to share information regarding successes and challenges, to help shape irrigation programs. TID works and coordinates with the San Joaquin River Group, San Joaquin Tributaries Authority and the East San Joaquin Water Quality Coalition. Each authority and association is involved in activities that relate to different aspects of the District's water management activities.

TID adopted its first Groundwater Management Plan (GWMP) in 1993. After that time, other agencies within the Turlock Groundwater Basin (also referred to as the Basin or Turlock Basin in this document) became interested in groundwater management. As a result, the Turlock Groundwater Basin Association (TGBA) was formed in 1995 to develop a basin-wide GWMP. The first plan was adopted in 1997 by the majority of the water agencies within the Basin. Since that time the TGBA has continued to coordinate groundwater management activities, completed several studies, and updated the basin-wide GWMP. TID adopted the updated plan on March 18, 2008.

The TGBA continues to meet on a monthly basis to coordinate groundwater management activities, and pursue projects and studies to better understand and manage the shared groundwater resource. The TGBA is working together to implement groundwater monitoring, and submit the data requested for the newly initiated California Statewide Groundwater Elevation Monitoring (CASGEM) program, as required by SBx7-6. Additionally, the TGBA recently applied for a Local Groundwater Assistance (LGA) grant to study the hydrologic conditions on the far eastern side of the Turlock Basin where additional agricultural development continues to occur in an area where groundwater pumping, in excess of recharge, has caused a cone of depression which extends west into the TID's service area. (See Section 3 below for more information on groundwater conditions.) The LGA grant, if approved, will provide funding to characterize aquifer parameters on the eastern side of the basin, update the groundwater model, and provide information to help focus future TGBA groundwater management efforts.

1.2.2 Plan Participation

TID has prepared this AWMP in accordance with the requirements of the Water Conservation Act of 2009, also known as SBx7-7, enacted in November 2009. The legislation itself provides limited guidance regarding the outreach process to be followed while developing and adopting an AWMP. The Department of Water Resources (DWR) is preparing a draft guidebook for agencies to refer to when developing their 2012 AWMP. However, as described in the Preface, the draft guidebook was not available until the majority of this AWMP was already prepared. As a result, the public participation process, developed to comply with SBx7-7, was patterned after similar planning efforts implemented by urban water suppliers for developing Urban Water Management Plans, and past efforts for developing and implementing the basin-wide GWMP. To streamline the effort, the process also made use of existing communication programs, association memberships and coordination efforts. Table 1.1, below, describes public outreach activities, which included informal discussions with and notices to interested parties, newsletter

Table 1.1. AWMP Public Participation Process.

Activity	Date(s)
Turlock Groundwater Basin Association Meeting coordination and discussion	June 21, 2012
TID Website – AWMP update information added	July 11, 2012
Newsletter to TID growers – AWMP article	mid-August 2012
Letter notice to local water agencies – Plan to update AWMP	August 28, 2012
Newspaper Notice – Intent to update AWMP	September 2012
Newsletter to TID growers – Status of AWMP update	October 2012
Board Workshop – Review of draft AWMP and adoption process	November 6, 2012
TID Board – Sets Hearing for December 11 and directs staff to publish notice in newspaper, and make draft Plan available for public comment at TID office, on-line, and at local library	November 20, 2012
Copies of draft AWMP available for review at local library, on-line, and at TID office	November 20, 2012
Letters to local water agencies – Draft AWMP available for comment	November 20, 2012
Newspaper Notice – per Government Code Section 6066	Various Dates Nov. 24 – Dec. 8, 2012
Public Hearing & AWMP adoption	December 11, 2012
Copies of approved AWMP distributed as required by SBx7-7	December 2012

articles, public meetings, newspaper notices, in addition to making documents available for review and comment.

Copies of the information circulated in the public outreach effort are included in Appendix A.

Ongoing coordination and implementation of the Plan will be facilitated by continuing interactions with other local water agencies and TID customers. Examples of these programs include:

- Coordination with the Modesto Irrigation District (MID) through their partnership in management of Don Pedro Reservoir.
- Coordination with other local public agencies, including the counties and agricultural and urban water supply agencies, through meetings of the TGBA; an association that was formed to coordinate groundwater management activities within the Turlock Groundwater Basin. A copy of the TGBA Groundwater Management Plan is included and the internet address where the plan can be downloaded is provided in Appendix B.
- Growers in TID are kept informed of various TID activities and irrigation-related issues through grower meetings held at the start of each irrigation season and periodic newsletters mailed out throughout the year. Copies of past newsletters are available on TID's website at http://tid.com/news-resources/publications/the-grower. An example newsletter is included in Appendix C.

- TID's Board of Directors meets weekly. Board meetings provide an opportunity to educate and obtain feedback from the Board and the public regarding a wide range of water management related topics. The media and the public regularly attend these meetings. During each meeting, time is set aside to update the Board on District activities, and receive comments from the public.
- The District's public information division regularly communicates with the media regarding a variety of topics, issuing press releases as needed regarding District activities. The media also regularly reports on the issues, policies and projects discussed at TID Board meetings.
- The TID website is updated regularly. It includes a variety of information regarding TID's water management programs and practices. Information regarding the AWMP update is available at: www.tid.org/AWMP. Once adopted, the updated AWMP, will be posted on the TID website.

2 Agricultural Water Supplier and Service Area

This section contains a description of the physical and operational organization of the Turlock Irrigation District, including TID's history, geographic and environmental settings, operations, and policies.

2.1 HISTORY AND SIZE

TID provides irrigation water to agricultural lands in Stanislaus and Merced counties in the Central Valley of California. TID was formed on June 6, 1887 and was the first irrigation district formed in California under the Wright Act. At the time of its formation, TID covered 179,527 acres. TID presently covers a service area of 197,261 gross acres, with 157,800 acres that can currently be irrigated with surface water (i.e. the acreage served by active irrigation service connections). The average assessed acreage from 2007-2011 was 146,030 acres. The actual number of acres that irrigate each year varies depending on the decisions of the individual property owners. These and other key aspects of TID are summarized in Table 2.1. The increase in gross acreage from the time of District formation is attributed to the annexation of adjacent lands including Turlock Lake, the community of Delhi, and a portion of Don Pedro Reservoir.

Table 2.1. Water Supplier History and Size.

Date of formation	June 6, 1887
Local surface water source	Tuolumne River
Local groundwater source	Turlock Groundwater Basin
Gross acreage at time of formation	179,527 acres
Present irrigable acreage[1]	157,800 acres

[1] Acreage with active irrigation service connections.

2.2 LOCATION AND FACILITIES

TID's irrigation service area is generally bounded on the north by the Tuolumne River, on the south by the Merced River and on the west by the San Joaquin River (see map included as Appendix D). The communities of Turlock, Ceres, Keyes, Denair, Hughson, Delhi, South Modesto, Hickman, and Hilmar are within the boundaries of the TID irrigation service area. This section of the AWMP describes TID irrigation facilities and operations within its service area. A summary of TID's irrigation facilities and operations is provided in Table 2.2.

The Tuolumne River provides the principal water supply for TID. Don Pedro Reservoir is located on the Tuolumne River and is TID's principal storage reservoir, with a total capacity of 2,030,000 acre-feet (AF). Don Pedro Reservoir is jointly owned by TID and MID (68.46 % TID and 31.54 percent MID). TID operates the reservoir for the districts.

It is important to note that a portion of Don Pedro Reservoir's storage capacity is reserved for flood control purposes each year and operated in compliance with the Army Corps of Engineers (ACOE) requirements. To vacate the 340,000 acre-foot flood control space, reservoir levels are lowered each fall to a specified elevation (801.9 feet above mean sea level) by October 7th. Storage levels are allowed to gradually increase again after April 27th.

Table 2.2. TID Water Conveyance and Delivery System.

Facility/System	Description
Storage facilities	
Don Pedro Reservoir capacity[1]	1,178,197 AF
Turlock Lake capacity	45,600 AF
Conveyance facilities and other Infrastructure	
Unlined Canals	23 miles[2]
Lined Canals	207 miles[2]
Number of Canal Turnouts	1,472 operational sidegates
TID-owned Drains	18 miles
Drainage Wells	165
Rented Wells	48 to 120,depending on water year type and weather conditions
Tailwater/Spill Recovery Facilities	
TID-operated	Operational spills[3]
Grower-operated Tailwater/Spill Recovery	Individual grower tailwater systems[4]
Supplier Delivery System	
Order type/scheduling	Modified demand
Operational constraints	Canal capacity flow limitations
Expected changes to service area	None

NOTES:

1 TID's useable capacity in Don Pedro is 68.46 percent of overall 2,030,000 AF reservoir capacity minus 68.46 percent of the 309,000 AF (the minimum operating pool).

2 Miles of lined and unlined canals downstream of LaGrange Dam.

3 TID accepts a minor amount of tailwater into its canals that is blended with surface water supplies for deliveries; spills from upper canals are intercepted by the Ceres Main Canal and utilized to the greatest extent possible for delivery to downstream canals. TID also recaptures spills from the Harding Drain.

4 Grower operated tailwater systems are installed to make use of water and to comply with relevant water quality requirements.

Flood control operations, combined with variable hydrology and operation of reservoirs upstream on the Tuolumne River, influence Don Pedro Reservoir storage levels and the available surface water supplies each year.

La Grange Dam was constructed in 1893 and is located on the Tuolumne River, downstream of Don Pedro Reservoir near the community of La Grange. Water released from Don Pedro Reservoir is diverted from the river into the TID Upper Main Canal at the La Grange Dam.

TID's distribution system begins at La Grange Dam where water, released from Don Pedro Reservoir for irrigation purposes, is diverted into the TID Upper Main Canal for conveyance to Turlock Lake. Turlock Lake is an important component of the TID's irrigation system with a maximum capacity of 45,600 AF. TID operates Turlock Lake to store and release irrigation water supplies, to balance irrigation deliveries with irrigation demand, and to minimize flow fluctuations in the District's irrigation canals and laterals.

From Turlock Lake, water is released into the Main Canal for distribution to downstream growers for irrigation purposes. TID's conveyance and distribution system consists of approximately 230 miles of canals, of which 207 miles are fully or partially lined (90%). (Lining information reported through the Fall of 2011 for consistency with the irrigation season water budget presented in Section 4 of this Plan.) The unlined canals are located primarily in upland areas underlain with hard clay soils with very low infiltration rates. TID has an active gunite and lining replacement maintenance program and resurfaces an average of 2.2 miles of canal lining each year (based on the 1991-2011 period). During the winters 2006-2007 and 2007-2008, TID lined approximately 4.5 miles of existing earthen canals for operational purposes.

Three main delivery canals run north to south with laterals running east to west from the canals. Upper laterals terminate into the lower canals, where the water is utilized for deliveries from the lower canals. Several interconnections between canals provide additional operational flexibility, enabling the District to capture water that may otherwise spill. Additionally, a small volume of tailwater flows to agricultural drains and is intercepted by the TID distribution system and blended with surface water supplies for delivery to TID growers. Additional information on tailwater in the TID irrigation service area is described in Sections 2.3, "Terrain and Soils" and 2.5, "Operating Rules and Regulations."

TID owns and maintains the distribution system to the sidegate; the point at which water is delivered from the District to the individual fields. Growers are responsible for building, operating and maintaining the distribution facilities from the sidegate to the field. A variety of private and improvement district facilities have been designed and built over time to meet this need. (See Section 2.2.1 for more information regarding Improvement Districts.)

TID's canal conveyance system is a gravity flow system. Water in the canals not utilized for irrigation purposes flows through the canals and is released into drains or downstream rivers. These locations are called spills. There are a total of 15 spill locations from the distribution system. Six of the spills flow directly to rivers and the remaining nine are consolidated into three drains that flow to the river system.

TID supplements surface water releases by utilizing drainage wells and rented wells. Drainage wells are owned by TID and are used to lower groundwater levels in localized, high groundwater areas and to supplement other irrigation water supplies. Rented wells are private or Improvement District wells that are rented by TID to supplement irrigation supplies, particularly in drier years when surface water supplies are limited. The actual wells rented each year vary depending upon a variety of factors including the anticipated amount of rented pumping needed, pumping costs, condition of the well and the quality and quantity of the water pumped. Water pumped from drainage and rented wells either discharges directly into the canal, into a pipeline that flows back to the canal, or into a pipeline from which it is utilized for irrigation purposes.

TID also utilizes supplemental groundwater pumping to help conserve water by reducing canal spillage. This is done by purposely releasing less than the needed amount of surface water into the head of each canal and pumping groundwater into the lower sections of canal to make up the difference. Utilization of available groundwater supplies in this manner provides greater flexibility to system operators to meet irrigation demand, while reducing distribution system spills.

2.2.1 Improvement Districts

TID's responsibility for water delivery stops at the canal sidegate. The grower is responsible for the construction and maintenance of facilities to transport the water from the TID canal to the grower's land. Improvement Districts (ID) are formed to allow a group of growers to pool resources to construct irrigation facilities. IDs can be formed for a variety of reasons, such as constructing, operating, and maintaining ditches, pipes, wells, and surface and subsurface drainage facilities. TID offers low interest financing to IDs, generally with a 10-year loan term.

TID is the trustee and administrator for 1,043 IDs that deliver water from the TID canals and laterals to individual growers. ID facilities comprise approximately 700 miles of lined delivery ditches and pipelines serving 128,400 acres. Generally a couple of IDs per year convert from open ditches to pipe systems. An average ID is comprised of 13 parcels with an average parcel size of 18 acres. The average parcel size receiving surface water within TID's irrigation service area is 28 acres. Parcels not belonging to IDs receive water through private pipelines and ditches served directly by TID canals and laterals.

2.2.2 System Operational Constraints

There are a few capacity constraints in the canal delivery system that can cause delays in delivering ordered water. These capacity constraints are due, in part, to changes in cropping patterns over the years that have led to a demand for more frequent and time sensitive irrigation (e.g., a shift from irrigated pasture to corn and alfalfa). To reduce delays in water deliveries and to improve customer service, TID created a central call center in 1991 to process irrigation orders. In most of the service areas with capacity constraints, TID rents pumps to supplement surface water supplies downstream of the capacity constraint. Pumps are used as needed to ensure that the customer is not affected by system constraints and receives the full ordered flow with as much flexibility in timing as practical. The rented pumps that are turned on for this purpose can run up to several days continuously per week during the summer peak demand time, until demand has diminished.

2.2.3 Changes to Service Area

An increase in urbanization has occurred within TID's irrigated service area in the last decade. Urban land uses occupy approximately 20,000 acres within the irrigation service area. An evaluation of land use patterns in the TID irrigation boundaries completed in 2006 shows that idle cropland has been converted to urban land uses, rather than land in active agricultural production. The more recent economic downturn has also influenced urban development in the region. Hence, land use changes within the irrigation service area have not resulted in significant reductions in active irrigated acreage.

Several local community water systems, including those found in Hughson, Ceres, Turlock and the portion of Modesto south of the Tuolumne River have for a number of years been studying the possibility of using TID surface water from the Tuolumne River to supplement groundwater supplies. (See Section 4.5.4 regarding municipal and industrial water supplies for more information.) While such a project would be within the current irrigation boundaries, it would result in resumed water service to those areas.

2.3 TERRAIN AND SOILS

Soils within TID vary from loam on the eastern edge of the irrigation service area to loamy sands on the western side. On average, land in TID is flat with a fall of 1 foot per 1,000 feet. Most irrigated lands in the TID irrigation service area are laser leveled, with the annual crop areas re-leveled every few years. The majority of land is flood irrigated using basin-check systems that generate little or no tailwater. Private tailwater return systems are not permitted to discharge to the distribution system. Even on the eastern side of TID, where slight slopes exist, the majority of growers have control structures to prevent tailwater runoff from flowing directly back into the distribution system.

A small quantity of tailwater is generated in the TID irrigation service area. Tailwater production is limited to approximately 10,900 acres (less than 7% of TID irrigable lands). The tailwater first flows to agricultural drains that collect a mixture of tailwater, shallow groundwater, and occasionally natural runoff. Several of these drains are intercepted by the distribution system, the remainder flow to local rivers. The tailwater intercepted by TID canals comes from approximately 2,700 acres (less than 2% of TID irrigable lands). During the irrigation season, the intercepted water is blended with surface water supplies in the canals and used for irrigation. Approximately 8,200 additional acres within TID can also produce tailwater, but this water does not enter the TID distribution system. (See Section 2.5.4 for additional information regarding tailwater policies.)

On the western side of TID extensive clay lenses lying between 5 and 20 feet beneath the ground surface result in localized perched water tables. TID drainage wells are run to help lower groundwater levels. TID makes monthly shallow groundwater elevation maps to guide the operation of the drainage pumps. These perched water tables developed soon after water was delivered into these areas in the early 1900's and led TID to begin installing drainage wells as electricity became available in the 1920's. TID currently owns 165 drainage wells and generally operates 105 to 130 of them each year depending on rainfall and drainage issues. The pumped drainage water can contain salinity and nitrates and is blended with surface water and used for irrigation to the fullest extent possible.

The spatial variation in soils from east to west has resulted in the majority of the orchard crops being located on the east side of TID while the bulk of the field crops supporting the dairy industry are found on the west side. Micro sprinkler and drip irrigation systems are concentrated on the east side in the areas with lighter soils, and tend to use less water than surface irrigation methods. The east side of TID is the area where recharge is most needed to overcome the local groundwater overdraft, presenting a challenge to groundwater management in the Basin. Conversely, subsurface drainage systems have been installed in the western areas with higher groundwater levels.

2.4 CLIMATE

TID's service area is characterized by a Mediterranean-type climate. Summers are hot and dry, with average high temperatures of approximately 90°F and temperatures exceeding 100°F at times. Winters are cool and wet, with the majority of precipitation falling between November and March. The coldest month of the year is December, which has an average minimum temperature of 35°F. These characteristics are widely representative of the climate throughout the irrigation service area. Microclimates within TID do not vary greatly and, therefore, have little impact on TID operations or on-farm water demands. Average climate data for the period 1991 to 2011 are presented in Table 2.3. The twenty-one year period from 1991 to 2011 period provides a reasonable depiction of long-term climatic conditions within TID. Potential climate change effects are discussed in Section 5.

Natural precipitation generally meets the water needs of winter annuals, pasture and winter cover crops in the orchards; however, dry winters may require irrigation deliveries for these crops between November and January. In the past, early irrigations have typically occurred within a two week period in either January or February. Water delivered during the winter is typically not counted towards a grower's available water supplies (historically referred to as the "allotment") for the irrigation season and is charged on a volumetric basis.

Table 2.3. Average Climate Characteristics (1991-2011).

Climate Characteristic	Average Value[1]
Average Annual Precipitation	13.1 inches
Average Minimum Temperature	35°F (December)
Average Maximum Temperature	90°F (July)
Average Annual Reference Evapotranspiration (ET_o)	51.9 inches
Average Minimum Monthly Reference Evapotranspiration (ET_o)	1.0 inches (January)
Average Maximum Monthly Reference Evapotranspiration (ET_o)	8.1 inches (July)

[1]Average precipitation values are from 1991 - 2002 records from the National Oceanic & Atmospheric Administration (NOAA) Station #49073 (Turlock #2), from California Irrigation Management Information System (CIMIS) Station #168 (Denair) for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2011.

Temperature values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2011.

ETo values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2011.

Although freezing temperatures do occur during the winter months at times, water is not delivered for frost protection. However, TID does allow growers to use the canals to convey the grower's own deep well water to other parcels owned or rented by the pump owner. A condition of this use is that such activities cannot interfere with operation and maintenance of the canal or lateral.

TID has been providing growers with local weather information for on-farm water management for over 10 years. TID installed California Irrigation Management Information System (CIMIS) Station #168 (Denair) in early 2002. The station was installed in a central location in the TID irrigation service area, providing data for a previously underrepresented area in the CIMIS network. The station provides area-specific climate and reference evapotranspiration data to growers to allow them to effectively schedule irrigation events based on current and projected crop water usage. TID provides the Department of Water Resources (DWR) CIMIS website information and a web link to CIMIS tutorials and station data on the TID webpage. Growers can also access the data directly from the DWR website. (http://www.tid.org/water/water-management/california-irrigation-management-information-system-cimis) In April 2009, CIMIS Station #168 (Denair) was relocated approximately two miles to the southeast and assigned a new station number (#206). The station is located on an irrigated pasture with adequate fetch to provide quality reference evapotranspiration estimates. TID continues to sponsor and maintain the station.

2.5 OPERATING RULES AND REGULATIONS

The current TID "Irrigation Rules" are provided in Appendix E, including rules for the distribution and use of irrigation water, governing rules for IDs, pump IDs, and subsurface drainage IDs, and the TID Drainage Policy. Updates to the irrigation rules occur from time to time as needed. The current rules are expected to be updated, prior to the 2013 irrigation season, to reflect changes in the water pricing structure, and to reflect current practices and procedures. Any changes to the irrigation rules are communicated to customers and readily available at TID offices, or via the internet at www.tid.com.

2.5.1 Water Allocation Policies

Historically, the TID Board of Directors has established the baseline water allotment each year depending on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps. This baseline allotment was part of a three-tiered increasing block rate schedule, which is discussed in greater detail in Section 2.7, "Water Rate Schedules and Billing." The baseline allotment was the quantity of water available equally to each acre of land within the TID service area. Additional water could be purchased, if available, and was charged on a volumetric basis. In average rainfall years, the baseline allotment was as high as 48 inches (4 AF per acre).

In establishing water allocations in a dry year, the District evaluates water supplies as if it is the first dry year of a longer term dry cycle. For these analyses, the dry period from 1987 to 1992, the longest dry cycle in recent history, is often used as the drought of record for planning purposes. Another significantly dry period was 1976 through 1977. These dry periods, and their impacts on water supply availability, are often utilized for reference in water supply planning.

On June 12, 2012, the TID Board of Directors adopted a new volumetric pricing structure to comply with SBx7-7 water pricing requirements. As described in Section 2.7, the new structure is an increasing block rate structure combined with a fixed charge. Additionally, the structure includes two different fee schedules, one for "normal" water years and one for "dry" years. The new rate structure takes effect in 2013. With the new structure, instead of establishing an "allotment," the Board of Directors will determine the amount of water available for purchase each year, and the fee schedule to be used (e.g. normal or dry year), based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

Additionally, in most normal or above normal precipitation years, depending on carry-over storage, the TID Board of Directors may allow the sale of "surplus water" to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of the "surplus water" goes to lands to the east of TID as a substitute for groundwater pumping. These lands have no surface water supply and groundwater pumping has caused a cone of depression to form on the eastern portion of the Turlock Groundwater Basin. TID promotes in-lieu groundwater recharge during most years with normal or above normal precipitation by selling surplus water at rates that are competitive with the cost to pump groundwater. The last time surplus water was made available (2011) the cost was $20 per AF.

2.5.2 Water Orders

TID uses a restricted arranged demand system of water ordering and delivery. Under this system irrigation frequency is arranged, flow rates are standardized, and the duration of use is flexible. Cropping patterns in TID's irrigation service area are very diverse, with trees, vines, alfalfa, and field crops often served by the same ID pipeline. An individual grower may adjust the duration and frequency of delivery and, rarely, even the flow rate to meet crop needs.

Growers place orders for water with a Central Call Center where the computer system tracks current water use by parcel. The District began pilot testing an on-line water ordering application in 2011. TID continues to refine and test the on-line ordering process. Difficulties have delayed larger scale implementation. As these issues are able to be addressed, the District plans to make on-line ordering, and historical customer information available in the future. Growers normally receive water an average of 50 hours after they place an order. The grower is allowed to keep the water until the irrigation is complete. Growers are billed for the total volume of water used, computed from the actual time of use rather than the time estimate given when the water order was placed. As described under "Irrigation Deliveries" below, each grower takes a full flow (or "head") of water. The TID Water Distribution Operator (WDO) notifies each irrigator with the name and contact information for the grower they will receive the water from and the grower they will pass the water to when finished.

Growers on micro systems or sprinklers using non-standard flow rates set up weekly orders in the Central Call Center and then communicate directly with the WDO to coordinate delivery. The WDO has the flexibility to adjust the grower sequence from the Central Call Center computer schedule to minimize fluctuations in canal flows by coordinating orders in an ID pipeline in continuous 24-hour blocks rather than taking water in and out of a long pipeline throughout the day. Fixed two week rotation deliveries are established for the approximately 800 "garden heads," blocks of parcels 5 acres or smaller that are irrigated as a unit.

Lead times for water orders are variable, because of the flexibility WDOs have to adjust orders. The WDO must call the irrigator within 24 hours of receiving the irrigation request to give an estimate of the delivery time. The WDO then will attempt to contact the irrigator at least 12 hours in advance to notify the irrigator of any change in time of delivery. The mean wait time for deliveries is 50 hours from the time of the water request. The grower is responsible for contacting the next irrigator to let them know when the water will be available. The lead time, or notice, for the next irrigator is typically ½ hour to 1 hour prior finishing the irrigation.

The software system currently used by the Central Call Center to track water orders, irrigation deliveries, as well as bill customers is a proprietary system created by TID software engineers in the early 1990's, and updated as needed over time. TID is currently evaluating various commercially available software options, with the intent of migrating to another platform for water ordering, tracking and billing purposes in 2014. To ensure a smooth transition, TID plans to operate the current system and the new system in parallel for at least a portion of the 2014 irrigation season. This will allow time for TID staff and customers to become familiar with the new system, and confident in its performance before making the final transition.

2.5.3 Irrigation Deliveries

The predominant irrigation practice in the TID service area is a basin-check flood irrigation system. TID supplies water by gravity to a grower at the ID or private sidegate. The standard head of water delivered is designed to be 15 cubic feet per second (cfs) or 20 cfs, depending on the grower or ID system capacity. Growers served through private pipelines or ditches receive a full standard head. In most instances, growers served from an ID pipeline or ditch also receive the entire flow in their turnout (sidegate) in the order the water is scheduled. Growers are responsible for controlling their water while irrigating and passing the entire flow on to the next grower, as instructed by the WDO. These large flows of water are designed to provide a reasonable distribution uniformity using surface irrigation across the light textured soils found in the majority of the TID service area.

2.5.4 Drainage and Tailwater Policies

As a general rule, direct tailwater discharges are not permitted in the TID distribution system. The basin-check system of irrigation used most commonly in TID's irrigation service area produces little or no tailwater. Overall, approximately 10,900 acres (less than 7% of TID's irrigable acreage) generates tailwater. A small portion is collected in drains and discharged into the distribution system where it blends with surface water and is reused for irrigation. The remainder flows to local drains which in turn discharge to nearby rivers.

In 2000 TID began a systematic program to inventory the tailwater and storm drains that discharge to TID facilities. In 2004 TID received grant funding which allowed TID to inventory the entire District, provide financial assistance to growers to install positive shut-off devices on their drains and to install real-time water quality monitoring equipment. As part of this program, TID issues growers with drainage discharges a "Drainage Permit" which requires that a positive shut-off device be installed on each field drain, establishes a size limit on the drain and spells out the grower's responsibilities with respect to the water quality of their drainage water. An annual fee is also charged for each field drain to offset a portion of the maintenance costs.

The inventory shows that drain water, which eventually enters TID canals, only comes from a small percentage of lands within TID (approximately 2,700 acres, or less than 2%). This drain water includes tailwater mixed with other source water such as groundwater and natural runoff from precipitation. The drain water is blended with surface water supplies for delivery to TID growers. Some tailwater is generated on approximately 8,200 additional acres within TID, but is not intercepted by the TID distribution system.

2.6 WATER DELIVERY MEASUREMENTS OR CALCULATIONS

2.6.1 Conveyance System Measurements

Following the endorsement of the 1999 TID AWMP by the Agricultural Water Management Council (AWMC) on May 17, 2001, TID incorporated Supervisory Control and Data Acquisition (SCADA) technology into its distribution system. A total of 60 sites were outfitted with SCADA equipment to monitor and measure flow. Approximately one-third of the SCADA sites provide real-time water quality information. In 2007 TID began upgrading the pressure transducers originally installed with the SCADA equipment to maintain data accuracy, and has completed the majority of sites. The two remaining sites are expected to be upgraded by the end of 2013.

These improvements have increased TID's ability to monitor system operations. Staff can monitor flows at the head of the majority of the laterals, main diversion points, and at 14 operational spills[2], 3 drains, and 2 creeks.

Further, WDOs have remote access to the flow data through a program installed on their TID wireless phones, allowing them to rapidly check conditions throughout their service area. The installation of SCADA technology has increased the accuracy of flow measurements throughout the TID distribution system. In addition to providing flow measurements at previously ungaged sites in the distribution system, the telemetry equipment replaced the Stevens chart recorders. The SCADA sites produce more accurate flow estimates because flows are recorded in real time and averaged for the daily flow volume. These flow data have improved the estimates of water use throughout the irrigation service area.

The measurement structures within the conveyance system are maintained annually to ensure the accuracy of recorded measurements. The calibration of the sensors at the SCADA sites is routinely checked throughout the year.

2.6.2 Delivery Measurements

The delivery point through which water is delivered from a TID lateral to a grower's parcel or an improvement district facility is called a *Sidegate.* Sidegates are operated for measurement by setting the valve stem opening required for the standard design flow of 15 or 20 cfs given the hydraulic conditions at that sidegate. Historically, the stem opening has been set such that the end user is receiving the standard design flow for that pipeline.

The valve stem opening has been determined from flow measurements made by trained TID employees using portable electromagnetic velocity meters, which measure velocity in the irrigation pipeline or ditch, downstream of the sidegate. Flow is calculated by multiplying the measured velocity by the area. The correct stem openings (providing a standard 15 or 20 cfs head) have been provided to the Water Distribution Operators (WDOs), the field staff who deliver the water, as well as each grower. A gate stem opening and associated flow rate is assigned to each parcel in the database record used to compute water use.

TID also provides water to a limited number of non-standard deliveries, mainly parcels served by pressurized systems. Deliveries to these parcels have been assigned a modified flow based on the individual irrigation system configuration.

Growers are billed for the volume of water delivered. When a grower completes an irrigation event, they contact the WDO to give the start and stop times for the irrigation, and the WDO records the times on a water receipt. The volume delivered is calculated by multiplying the flow rate by the duration of the delivery.

Using TID sidegates to measure individual customer deliveries in this manner is complicated by a number of factors which make using this method, in some locations, potentially problematic for meeting or verifying the newly established accuracy standards contained within the newly promulgated Agricultural Water Measurement Regulation found in the California Code of

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[2] There are 15 operational spills. However, only 14 are used. The 15th site can spill, but is very rarely used, and therefore is not included in the SCADA system at this time.

Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597). Therefore, pursuant to 23 CCR §597.4(e) (4), a corrective action plan to be fully compliant with the new regulation by December 31, 2015 has been developed, and included in Appendix F.

The corrective action plan includes a two-pronged approach to delivery measurement which will enable TID to establish parcel specific flows, or directly measure the volume of water delivered to each parcel. First, TID plans to install new continuous flow measurement devices on pressurized systems and approximately 125 sidegates serving large areas and many parcels, which together account for more than half the irrigated acreage within TID. For the remaining sidegates, TID is developing standard flow measurement procedures to determine parcel specific flows at each sidegate, and standardizing the conversion from flow rate to volume delivered. Standard hydraulic conditions will ensure the parcel specific average flow rates and the corresponding volume measurements are sufficiently accurate to comply with the regulation.

2.6.3 Private Pumping Measurements

Private pumping is estimated using a conversion factor to calculate the quantity of water pumped based on electrical usage data. In the previous AWMP, TID identified an overestimation of the amount of pumping from private irrigation wells. Because the land uses and irrigation practices over large portions of TID have changed, the conversion factor that had previously been developed was no longer accurate. A survey of private facilities showed that there were many instances where the electricity measured by the electric meter was being used to power more than just the deep well pump, resulting in an overestimation of private pumping. A new conversion factor was developed to address this by accounting for the use of pressurized irrigation systems and multiple pumps connected to a single electric meter (e.g., a deep well pump and separate booster pump on the same meter). Use of several conversion factors has allowed TID to develop a better estimate of private groundwater usage.

2.7 WATER RATE SCHEDULES AND BILLING

TID has historically used a three-tiered, increasing block rate schedule based on three classes of water deliveries. The first block was the annual allotment which was available equally to each acre of land. The volume of the allotment varied depending upon the available surface water supply. The actual allotment, as well as any additional water available above the allotment, was set each year based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

The TID water rate basis and structure in effect from 2010-2012 are presented in Table 2.4. During that time, the allotment charge was $26 per acre, which is equivalent to $6.50 per acre-foot for a 48-inch allotment. However, because the allotment was assessed at a flat rate per acre, when the volume of the allotment declined, the effective cost per acre-foot increased. The next two blocks of water, when available, were charged out on a volumetric basis. The charge for available (Tier 2) water was $15 per acre-foot for the first 12 inches of water over the allotment and any remaining water (Tier 3) was charged at $20 per acre-foot. During dry years, TID has also placed caps on the amount of Tier 2 and Tier 3 water available above the allotment as part of its conjunctive management strategy and conservation efforts.

Table 2.4. Description of Historical Water Rates (2010-2012).

Water Charge Basis	
Acreage-based[1]	Allotment up to 48 inches per acre, set each year
Quantity-based	Use above allotment charge on an AF basis
Type of Billing	Increasing block rate
Allotment Charge	\$26/acre[1]
2nd & 3rd Tier Water Rates (if available)	▪ **Tier 2:** \$15/AF for up to 12 inches of water per acre[1] ▪ **Tier 3:** \$20/AF
Frequency of Billing	Semi-annually

[1]Acreage based on assessed acres.

TID's historic pricing and water management practices have enabled TID to conjunctively manage its surface water and groundwater resources. In normal and above normal water years, allotments (up to 48 inches) encouraged growers to use surface water to irrigate. The majority of water not consumed by the crop recharged the groundwater system. The recharge provided groundwater resources relied upon in dry years to supplement reduced surface water supplies. Additionally, the allotment was reduced in dry years, increasing the cost to the grower by moving deliveries into the higher tiered water prices sooner. This not only encouraged conservation in dry years, but also provided additional revenue to cover costs associated with additional pumping needed to supplement reduced surface water supplies.

In June of 2012, TID adopted a new volumetric pricing structure scheduled to take effect in 2013 (Table 2.5). The new structure, designed to comply with the requirements of SBx7-7 also continues to support the District's conjunctive management objectives. The new structure includes a fixed (per acre) charge, combined with a four-tiered increasing block rate schedule. The new rate structure also includes a split schedule, with one schedule established for dry years, and another for normal or above normal years. As with the previous pricing structure described above, the new "dry" schedule is at a higher rate, to help recover the additional pumping costs incurred in dry years. With the new pricing structure in place, the TID Board of Directors will no longer determine the allotment each year. Instead, the Board will determine the type of water year (and therefore the water pricing schedule to be used for the given year) as well as the amount of water available for purchase each year, based on projected runoff, including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps. A process similar to the way the "allotment" has historically been established.

In addition to the cost of water, the growers are responsible for the cost of the facilities to convey water from the TID canal sidegates to their fields.

TID also promotes in-lieu recharge in most years with normal and above normal precipitation. In these years, depending on carry-over storage, the TID Board of Directors may allow the sale of "surplus water" to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of these sales go to lands to the east of TID as a substitute for groundwater pumping for irrigation. These lands have no surface water supply, and groundwater pumping

Table 2.5. Description of 2013 Water Rates.

Water Charge Basis	Each year, based on water supplies available, the Board determines amount of water available, and if the normal or dry schedule is to be used.	
Acreage-based[1]	Fixed Charge, varies by normal or dry year	
Quantity- based	Water charged on a per acre-foot (AF) basis, varies by normal or dry year	
Type of Billing	Water costs include a fixed charge, plus volumetric charges for the water used. Charges are established in normal or dry year schedules. Volumetric charges are based on a four-tiered, increasing block rate structure.	
	Normal Year Rate Schedule[1]	**Dry Year Rate Schedule[1]**
Fixed Charge	$23 per acre	$26 per acre
1st Tier Water Rate	$2 per AF, up to 2 AF per acre	$2 per AF, up to 1 AF per acre
2nd Tier Water Rate	$3 per AF, up to 2 AF per acre	$3 per AF, up to 1.5 AF per acre
3rd Tier Water Rate	$15 per AF, up to 1 AF per acre	$15 per AF, up to 1 AF per acre
4th Tier Water Rate	$20 per AF, additional available	$20 per AF, additional available
Frequency of Billing	Semi-annually	

[1]Acreage based on assessed acres.

significantly impacts available groundwater supplies in the Basin. The District promotes groundwater recharge in those areas in years when surplus water is made available by selling the water at rates comparable to the cost to pump groundwater. The last year this occurred was in 2011, when surplus water was available at the cost of $20 per acre-foot.

2.8 WATER SHORTAGE ALLOCATION POLICIES

TID's water allocation guidelines were developed in response to the 1987-1992 drought. The guidelines rely on TID's groundwater pumping capacity and management of carryover storage in Don Pedro Reservoir. Prudent water supply planning requires TID to consider that the first dry year encountered may just be the first year in a series of dry years similar to the 1987 to 1992 period.

Each year, the decision to reduce surface water diversions is made based on runoff projections and carryover storage. Groundwater pumping is increased progressively in each drought year, while historically, water allocations were progressively reduced. The gradual increase in groundwater use and corresponding decrease in allotment size allowed for a more uniform increase in groundwater pumping balanced against annual reductions in the carryover storage reserve. The size of the allotment and carryover storage reductions in the first year were determined based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, availability of groundwater and rented pumps, and instream flow requirements. Reducing the allotment size was intended to promote water conservation at the farm and supplier scales[3]. For subsequent years of drought, the same process was used to make further adjustments in the water allotment and carryover storage. In critically dry or consecutive dry years, TID could cap water deliveries to lands receiving surface water, with one exception. Growers that rent pumps to TID, were typically given access to up to 48 inches of water on those lands able to be served by the pump. This was done to encourage growers to rent pumps to TID. Without this option, many rental pumps might not have been available, significantly reducing TID's ability to supplement reduced surface water supplies in dry years.

Beginning in 2013, under the new water rate structure, allotments will no longer be used. However, a similar type of water shortage allocation process will be implemented. In water short years, the Board of Directors will determine if the dry year rate schedule will be used, and the amount of water available on a per acre basis, based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

As with past years, the decision to reduce surface water diversions in the future will be made based on available water supplies. Information including runoff and carryover storage projections, the availability of rented pumps, and instream flow requirements will be used to assist in making that determination. Similarly, groundwater pumping is expected to increase progressively in each drought year as supplies allow, and water available to the growers may be progressively reduced, as needed to balance supplies available with carryover storage requirements.

However, even with TID's conjunctive water management, groundwater is not an unlimited supply. In an extended drought, the availability of groundwater will likely decline over time, due to declining water levels and increased groundwater demand by TID and others.

Water availability is treated equally for all crop types because a large proportion of field crop production occurs in conjunction with local dairy operations. This demand is as stable as the water demands for orchard crops. Payment of the water charge (in the past), provided the grower with access to the amount of water established as the allotment, regardless of crop type. The new rate schedule is designed to act in a similar manner. In future years, payment of the fixed charge will provide growers with access to purchase the amount of water available that year, regardless of crop type. All water delivered will be charged on a volumetric (or per acre-foot) basis.

Increased groundwater pumping during dry years also allows TID to increase water delivery efficiency by reducing operational spills. The use of extensive pumping allows a WDO to more closely match water supplies to demands in the downstream portion of a service area. This flexibility was utilized during the 1987-1992 drought, resulting in a substantial decrease in operational spills. TID has continued to rely on the practice of increased groundwater pumping to reduce spills in the dry years since the 1987-1992 drought, most notably 2007 and 2008 when operational spills were decreased to an average of five percent.

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[3] To develop a methodology to quantify Water Use Efficiency (WUE), DWR considered the components of a water balance at three spatial scales—basin, water supplier, and field (DWR, 2012). Similarly, spatial scale must be considered when evaluating the influence of allotment size.

2.8.1 Wasteful Use

TID's Irrigation Rules (Appendix E) require that all water be applied efficiently and used in a reasonable and beneficial manner. During an irrigation delivery, the irrigator is required to be responsible for the water at all times after it leaves the TID distribution system. Irrigators who waste water intentionally or as a result of carelessness, improper field preparation, or neglected facility maintenance may be refused TID water until the cause of the condition is remedied.

The predominant form of irrigation in the TID irrigation service area (basin-check flood irrigation system) promotes beneficial use of water. Deep percolation from the basin-check systems provides recharge for the groundwater basin that is put to beneficial use by neighboring agencies as well as TID. As noted in the introduction to this AWMP, even with the recharge provided by irrigation, the groundwater basin is overdrafted, largely due to groundwater usage outside the eastern boundary of TID.

It is important to note that areas where groundwater levels are higher, and groundwater is pumped for drainage, the drainage water is blended with canal water and used as a part of the irrigation supply. Drawdown of groundwater levels due to the cone of depression on the eastern side of the groundwater basin limits the amount of groundwater which can be pumped on the eastern side of the District in dry years. As a result, groundwater pumping in recent dry years has relied more heavily on drainage wells for supply, enabling the District to maximize the use of higher groundwater levels on the western side of the basin for beneficial use.

2.8.2 Enforcement of Irrigation Rules and Regulations

Failure or refusal to comply with the TID rules and regulations by a landowner or irrigator may lead to termination of water delivery. Water cannot be furnished to the landowner or irrigator until the issue is resolved.

The Water Distribution Department Manager is authorized to issue a Notice and Order or oral or written warning to any irrigator or landowner in violation of a TID rule or regulation. The landowner or irrigator has 10 calendar days from the date of service to file a written appeal to the General Manager or Board of Directors, depending on type of notice, after which all rights to a hearing are waived. Water deliveries may be terminated immediately in several circumstances. These circumstances and the appeal process are described in detail in the TID Irrigation Rules in Part I, Section 10 (Appendix E).

Once an order or decision has become final, the irrigator or landowner has 7 calendar days to commence corrective action or repair and must pursue the action with sufficient diligence to meet the time established for compliance. When the landowner or irrigator returns to full compliance with all regulations, the individual will resume eligibility to receive water deliveries.

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3 Inventory of Water Supplies

This section of the AWMP describes the quantity and quality of the water resources available to TID. Over the last five years, total TID water supply averaged about 614,000 acre-feet (Table 3.1). Usage patterns within the TID irrigation service area and the water balance analysis, a central component of this AWMP, are described in Section 4.

Table 3.1. Summary of Water Supply Volumes within TID.

Year	Allotment (inches)[1]	Surface Water Supply, AF	Groundwater Supply, AF[2]	Other Water Supply, AF[3]	Total Supply, AF
2007	36	499,137	120,345	13,551	633,033
2008	40	441,466	124,789	13,748	580,003
2009	48	466,063	109,621	14,020	589,704
2010	48	531,107	80,571	16,109	627,787
2011	48	537,685	81,304	18,003	636,992
2007-2011	Average	495,092	103,326	15,086	613,504
	Minimum	441,466	80,571	13,551	580,003
	Maximum	537,685	124,789	18,003	636,992
1991-2011	Overall Average	503,572	99,769	11,776	615,117
	Normal Year Average	520,225	90,373	12,179	622,777
	Dry Year Average	476,511	115,037	11,121	602,669

[1]Depth of water in inches available equally to each acre of land.
[2]Includes supplemental private pumping on surface water irrigated lands.
[3]Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated M&I effluent delivered to farms.

For the purposes of Sections 3 and 4 of this AWMP, the data in the tables of the following sections has been summarized in the following ways:

1. 2007 to 2011 Period (Near-Term Historical)
   a. 2007-2011 average, which is an average of the last five years of operation. The 2007-2011 data are reflective of current TID operations and weather conditions. During this period, three of the years are considered normal and two are considered dry.
   b. 2007-2011 minimum and maximum annual values. The minimum and maximum depict the range of values under recent historical conditions.
2. 1991 to 2011 Period (Long-Term Historical)

a. Normal year average, which is an average of the historical data from years in which water supplies were sufficient to allow for an allotment of 48 inches of water. From a hydrological perspective, these years could be characterized as anywhere between normal and wet. Over the 21 year period from 1991 to 2011, 13 of the years fall into this category.

b. Dry year average, which is an average of the historical data from years in which supplies were reduced, and the allotment was less than 48 inches. Eight years between 1991 and 2011 are considered dry. Allotments during these years ranged from a low of 24 inches to a high of 42 inches.

c. Overall average for the 21-year period from 1991 to 2011.

TID practices conjunctive water management, the coordinated operation and monitoring of surface water and groundwater supplies to meet defined objectives. In TID's case, the main objective is to provide a firm, reliable water supply to the TID service area. As is discussed in this AWMP, given the nature of the crops grown in the TID service area, the water demand in TID varies little from year to year. TID has been able to meet this firm demand in both normal and dry years by using more groundwater in dry years when the surface water supply is reduced (Table 3.2).

Table 3.2. Summary of Water Supplies within TID as a Percentage of Total Supply.

Year	Allotment (inches)[1]	Surface Water Supply	Groundwater Supply[2]	Other Water Supply[3]	Total Supply
2007	36	79%	19%	2%	100%
2008	40	76%	22%	2%	100%
2009	48	79%	19%	2%	100%
2010	48	85%	13%	3%	100%
2011	48	84%	13%	3%	100%
2007-2011	Average	81%	17%	2%	100%
	Minimum	76%	14%	2%	NA
	Maximum	84%	20%	3%	NA
1991-2011	Overall Average	82%	16%	2%	100%
	Normal Year Average[4]	84%	15%	2%	100%
	Dry Year Average	79%	19%	2%	100%

[1]Depth of water in inches available equally to each acre of land.
[2]Includes supplemental private pumping on surface water irrigated lands.
[3]Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated M&I effluent delivered to farms.
[4]Percentages do not add up to 100 percent when reported to the nearest whole percentage point due to rounding error. To the nearest 0.1 percent, the averages are 83.5 percent, 14.5 percent and 2.0 percent for surface water, groundwater, and other supplies, respectively.

However, even with TID's conjunctive water management, groundwater is not an unlimited supply. In an extended drought, the availability of groundwater will likely decline over time, due to declining water levels and increased groundwater demand by TID and others.

The facilities referred to in this section are described in greater detail in Section 2 of the AWMP, and are shown in the map provided in Appendix D.

3.1 SURFACE WATER SUPPLY

The Tuolumne River is the source of TID's surface water supply. TID diverts water according to a series of pre- and post-1914 flow and storage water rights recognized by the State of California. TID's surface water supply is dependent upon annual hydrologic and reservoir storage conditions. Irrigation water from Don Pedro Reservoir is diverted into the TID Upper Main Canal at La Grange Dam. Diversions flow via gravity through the Upper Main Canal to Turlock Lake for temporary storage and re-regulation for irrigation deliveries. Hydrology can vary widely but is somewhat mitigated by storage capacity at the Don Pedro Reservoir. While Don Pedro Reservoir is large, TID's share is only 68.46 percent of the reservoir's available storage, above the minimum operating pool.

Table 3.3 summarizes annual TID releases from Turlock Lake for irrigation purposes. Annual volumes are provided along with surface water supply as a percentage of total TID water supplies[4]. This table also illustrates the portion of the total irrigation supply from surface water for lands that receive TID deliveries. Sources of groundwater to these lands include TID drainage wells, wells rented by TID, and supplemental pumping by individual growers or Improvement Districts. Supplemental pumping includes groundwater pumped from private or Improvement District wells by the grower at the grower's expense. There are approximately 4,000 acres within the TID irrigation service area that are capable of receiving surface water but utilize groundwater as their sole source of irrigation supply. The water use for these lands is not included in Table 3.3 because they do not receive surface water deliveries.

The monthly distribution of surface water releases as a percentage of total annual releases into the TID distribution system is summarized in Table 3.4. Note that these values represent the typical irrigation season of March through October. In special circumstances, such as very dry conditions, TID can provide a limited amount of water for irrigation during the winter months or, as was the case in 2011, the irrigation season could extend into November.

3.2 GROUNDWATER SUPPLY

The Turlock Groundwater Basin (also referred to in this document as the Basin) lies on the eastern side of the San Joaquin Valley and underlies TID. This groundwater basin is a subunit or sub-basin of the San Joaquin Valley Groundwater Basin. The Turlock Groundwater Basin lies in the eastern portions of Stanislaus and Merced counties and has an area extent of approximately 347,000 acres (542 mi^2). The Basin is bounded by the Tuolumne River on the north, the Merced River on the south, the San Joaquin River on the west, and the Sierra Nevada foothills to the east.

[4] The TID water supply includes Turlock Lake releases for irrigation, TID drainage well pumping, and TID rented well pumping. Other water supplies such as tailwater and recycled water are not included as they are minor sources and to avoid double counting of surface water supplies that are reused.

Table 3.3. Summary of Surface Water Supply Relative to Total TID Water Supply.

Year	Allotment (inches)[1]	Surface Water Supply	
		Acre-Feet	Percent of TID Water Supply
2007	36	499,137	83%
2008	40	441,466	81%
2009	48	466,063	85%
2010	48	531,107	89%
2011	48	537,685	89%
2007-2011	Average	495,092	85%
	Minimum	441,466	81%
	Maximum	537,685	89%
1991-2011	Overall Average	503,572	86%
	Normal Year Average	520,225	88%
	Dry Year Average	476,511	83%

[1]Depth of water in inches available equally to each acre of land.

Table 3.4. Average Monthly Percentage Distribution of Turlock Lake Releases[1].

Period	Statistic	Month[2]							
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
2007-2011	Average	7%	10%	13%	16%	20%	17%	10%	6%
	Minimum	3%	7%	12%	14%	19%	16%	8%	3%
	Maximum	11%	12%	13%	17%	22%	18%	12%	9%
1991-2011	Overall Average	5%	11%	13%	16%	20%	17%	10%	8%
	Normal Year Average	4%	10%	13%	16%	20%	17%	11%	8%
	Dry Year Average	6%	11%	13%	17%	20%	17%	9%	6%

[1]Irrigation season values only.
[2] Represents the minimum, maximum or average distribution for that month over the given timeframe. The total of the monthly percentages do not equal 100%, nor were they intended to.

A variety of water agencies (both agricultural and urban entities) overlie the Turlock Groundwater Basin (Figure 3.1). Ballico-Cortez Water District and Eastside Water District located east of TID do not have surface water supplies. They were formed to represent growers and private domestic water users in their areas, who rely entirely upon groundwater for their water supply.

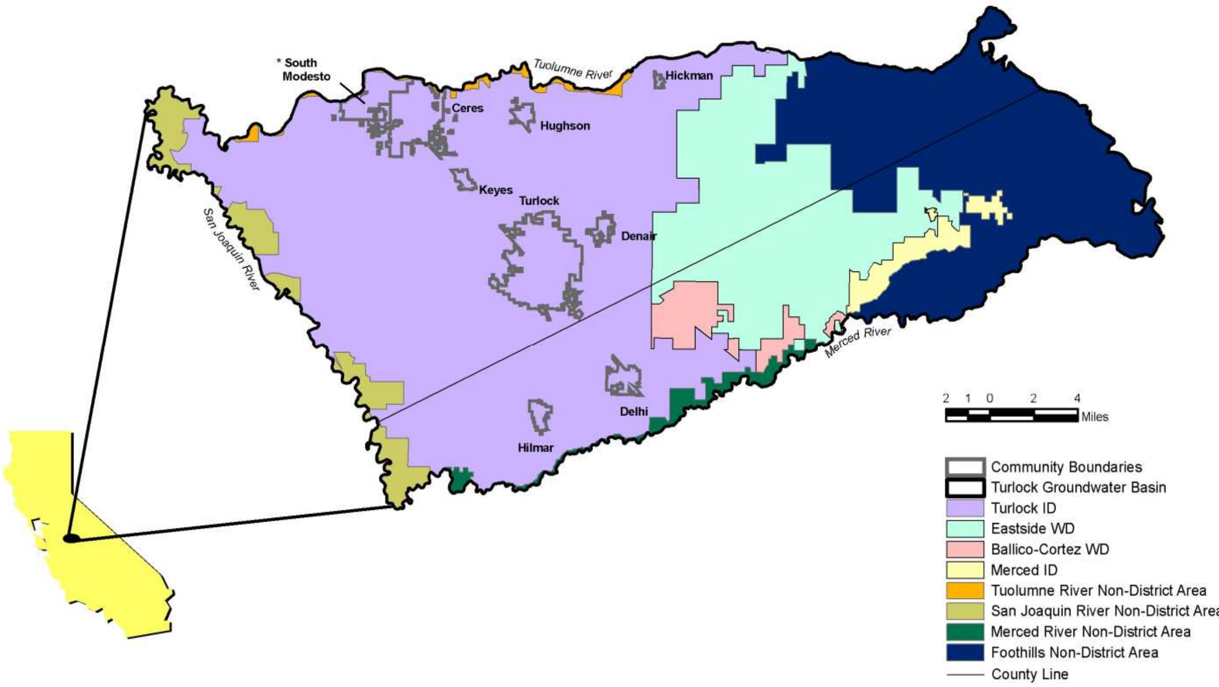

Figure 3.1. Turlock Groundwater Basin and Local Agency Boundaries (TGBA, 2008).

Groundwater within the Basin occurs under unconfined and confined conditions. A portion of the Basin is underlain by the Corcoran Clay, which separates the groundwater into two zones: an upper, unconfined aquifer and a lower, confined aquifer. There is also a deeply buried confined aquifer containing saline brine that extends upward into the unconsolidated sediments (Figure 3.2).

The unconfined aquifer occurs in unconsolidated deposits above and east of the Corcoran Clay. In the area underlain by the Corcoran Clay, the top of the clay is the base of the aquifer. To the east of the clay, the top of the consolidated rocks is the base of the aquifer. The unconfined aquifer is generally 150 feet in thickness. The unconfined aquifer is used for both agricultural and domestic supply in the western part of the Turlock Groundwater Basin. Wells less than 200 feet in depth draw from this aquifer. The general direction of regional groundwater flow in the unconfined aquifer would normally be westward and southward towards the valley trough. However, private agricultural pumping to irrigate approximately 74,000 acres (TGBA, 2008) east of the TID has created a large cone of depression that results in portions of the groundwater flow reversing direction and moving to the east, out from under TID. Agricultural development that began in the 1950’s in the eastern area continues to expand. All of which has no source of surface water supply. As a result, the areas east of TID rely entirely on groundwater for their water supply.

The confined aquifer within the Turlock Groundwater Basin occurs in the unconsolidated deposits that underlie the Corcoran Clay. Accordingly, the areal extent of the confined aquifer is limited to the extent of the Corcoran Clay. In the eastern part of the Basin, the confined aquifer is only semi-confined. The confined aquifer provides extensive municipal and agricultural supplies to the Basin. Wells greater than 200 feet deep draw from the confined aquifer, but may

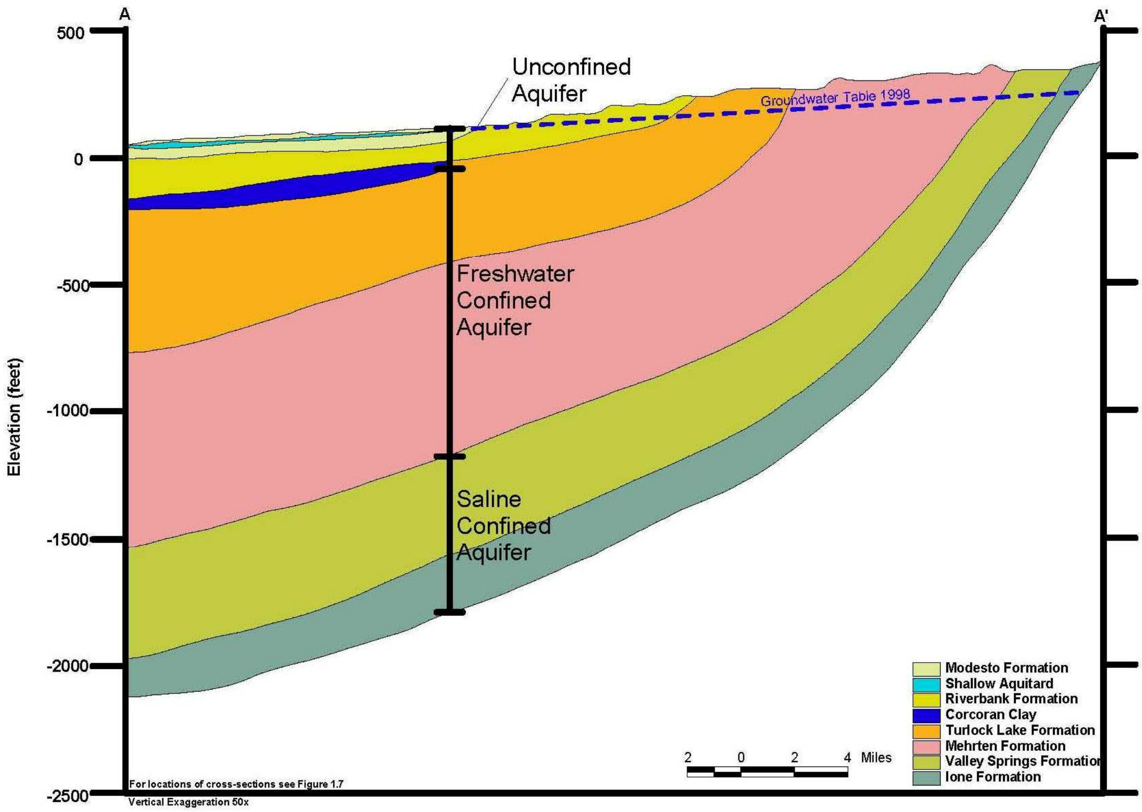

Figure 3.2. East-West Cross Section Showing Hydrogeologic Units within the Turlock Groundwater Basin (TGBA, 2008).

also receive flow from the unconfined aquifer. Based on general groundwater hydrologic considerations, the direction of groundwater flow in the confined aquifer is probably similar to that in the unconfined aquifer, westward and southward. Under historical conditions, the hydraulic head in the confined aquifer was greater than that of the unconfined aquifer, which caused water to flow upwards through the Corcoran Clay from the confined to the unconfined system. Under present conditions, the pumping that has occurred in the unconfined aquifer would tend to maintain or possibly increase the upward gradient (head differential) between the aquifers. Historically, the Corcoran Clay served as an "impermeable" barrier but with wells perforated above and below the clay in both aquifers, the effectiveness of the barrier is now greatly reduced.

At the present time the urban and private, rural domestic water systems within TID rely exclusively on groundwater for their source of water supply[5]. Municipal groundwater use for 2006, the last year the cumulative municipal pumping data was available for the Basin, was approximately 46,000 AF per year (TGBA, 2008), all of which is drawn from the confined

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[5] TID and Modesto ID jointly provide surface water to the small community of La Grange located along the Tuolumne River, east of the TID service area. As the volume of water used is relatively small (average of 34 AF/year from 2009-2011) and does not directly impact agricultural water management within TID, it is not described in detail herein.

aquifer, In addition, rural and small private residential groundwater use is estimated at 5,500 AF per year. If groundwater remains the sole source of municipal water supply, it is expected that municipal groundwater use will increase over time. However, several communities are considering the use surface water from the Tuolumne River in conjunction with existing groundwater supplies. TID approved the Regional Surface Water Supply Project Final Environmental Impact Report (EIR) in December 2006 for a 45 million gallon per day surface water treatment plant. If built, the plant would be located on a 50-acre parcel southeast of the Fox Grove Fishing Access site on the Tuolumne River near Hughson.

The volume of groundwater utilized during the irrigation season on lands that receive surface water from TID is summarized in Table 3.5. The total volume includes groundwater pumped from TID-owned drainage wells, Improvement District and private wells rented by TID, and from Improvement District and private wells used by growers to supplement surface water deliveries. The total TID pumping is greater in dry years reflecting TID's conjunctive management approach to managing water supplies to achieve high water supply reliability. Supplemental pumping on surface water irrigated land volumes are small relative to TID pumping and vary little from normal to dry years as evidenced by small difference between the normal and dry year averages. These small supplemental pumping volumes and the negligible difference between normal and dry year averages indicate that growers do not increase private groundwater pumping in dry years, and is illustrative of the effectiveness of TID's conjunctive management policies.

Note that estimates of supplemental groundwater pumping are not taken from direct measurement, but are derived from data describing power consumption. The water budget results of TID's first AWMP indicated that private pumping estimates needed refinement. Data from private well evaluations together with a survey of 33 private pumps conducted in 2002 were used to refine the computation of private pumping within TID. An additional action item from the AWMP was a survey of parcels not receiving surface water to collect information to estimate the areal extent of private pumping within TID. The results of this survey indicate that there are approximately between 4,000 and 5,000 acres within the TID service area that use groundwater exclusively. There are other lands that irrigate with private pumping but also take some surface water in some years. In the years they do not take surface water, these acres are not included in the TID irrigated acreage. Based on the survey of private pumps and parcels, an improved method of estimating private and supplemental groundwater pumping was developed and used in the TID water balance.

Table 3.5. Summary of Groundwater Use for Irrigation within TID (AF)[1].

Year	Allotment (inches)[2]	TID Drainage Pumping[3]	TID Rented Well Pumping[3]	Supplemental Pumping on Surface Water Irrigated Lands[4]	Total Groundwater Supply	
					Acre-Feet	Percent of Total Supplies within TID
2007	36	48,278	55,683	16,384	120,345	19%
2008	40	48,397	57,709	18,683	124,789	22%
2009	48	42,770	42,342	24,509	109,621	19%
2010	48	42,257	20,073	18,241	80,571	13%
2011	48	46,713	16,638	17,953	81,304	13%
2007-2011	Average	45,683	38,489	19,154	103,326	17%
	Minimum	42,257	16,638	16,384	75,279	13%
	Maximum	48,397	57,709	24,509	130,615	21%
1991-2011	Overall Average	50,716	28,009	21,044	99,769	16%
	Normal Year Average	53,507	15,990	20,875	90,373	15%
	Dry Year Average	46,180	47,539	21,318	115,037	19%

[1] Irrigation season values only.
[2] Depth of water in inches available equally to each acre of land.
[3] TID pumping values are based on recent or annual pump tests and power consumption data.
[4] Supplemental private pumping volumes estimated from power consumption data and private pumping survey.

3.2.1 Groundwater Conditions

A map of TID and the surrounding vicinity showing groundwater elevations in 1960, before the majority of land east of TID was converted to irrigated agriculture, is provided in Figure 3.3. Figure 3.4 shows groundwater elevations taken in the Spring 1986, after more than 25 years of groundwater extraction to the east of TID. These figures illustrate the development of a pumping depression in the eastern portion of the Turlock Groundwater Basin. Figures 3.5, 3.6, and 3.7 provide groundwater elevations for Spring 1998, Spring 2005, and Spring 2011, respectively. These figures illustrate that the cone of depression continued to expand after 1986. The pumping depression generally stabilized between 1998 and 2005, with additional decline by 2011. Figure 3.7 also provides some land use information, illustrating the extent of the agricultural development (in green) east of the TID, all of which relies entirely on groundwater for irrigation water supply. Localized groundwater declines are most concentrated east of TID and in some municipalities. As a result, the flow of groundwater is generally from the TID service area to the east.

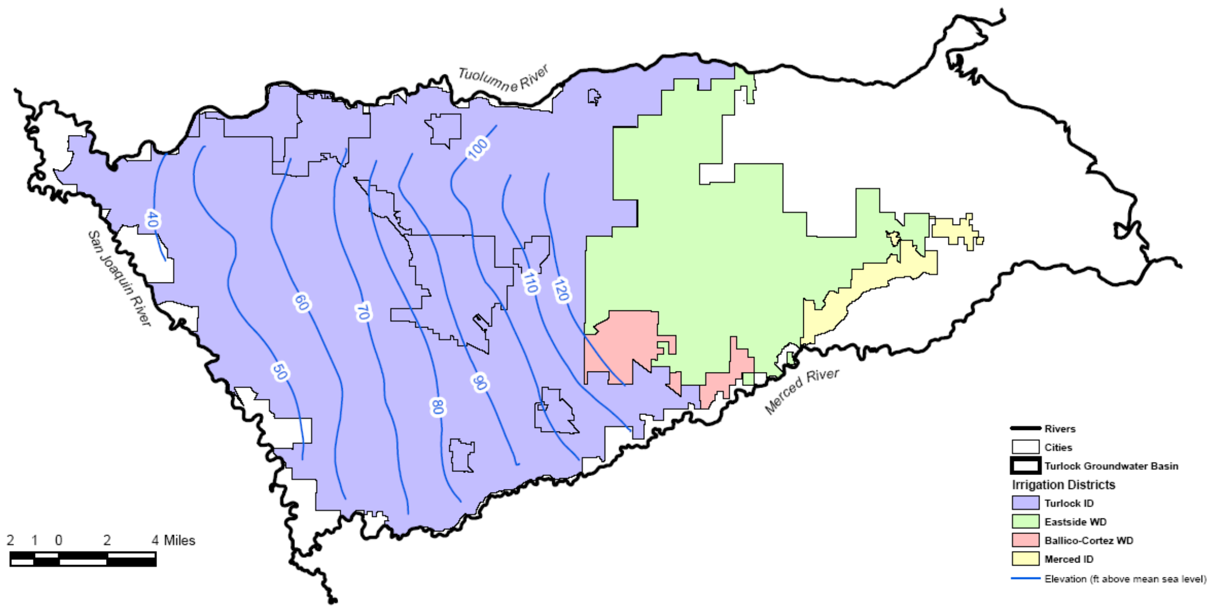

Figure 3.3. Groundwater Elevations - Spring 1960 (TGBA, 2008).

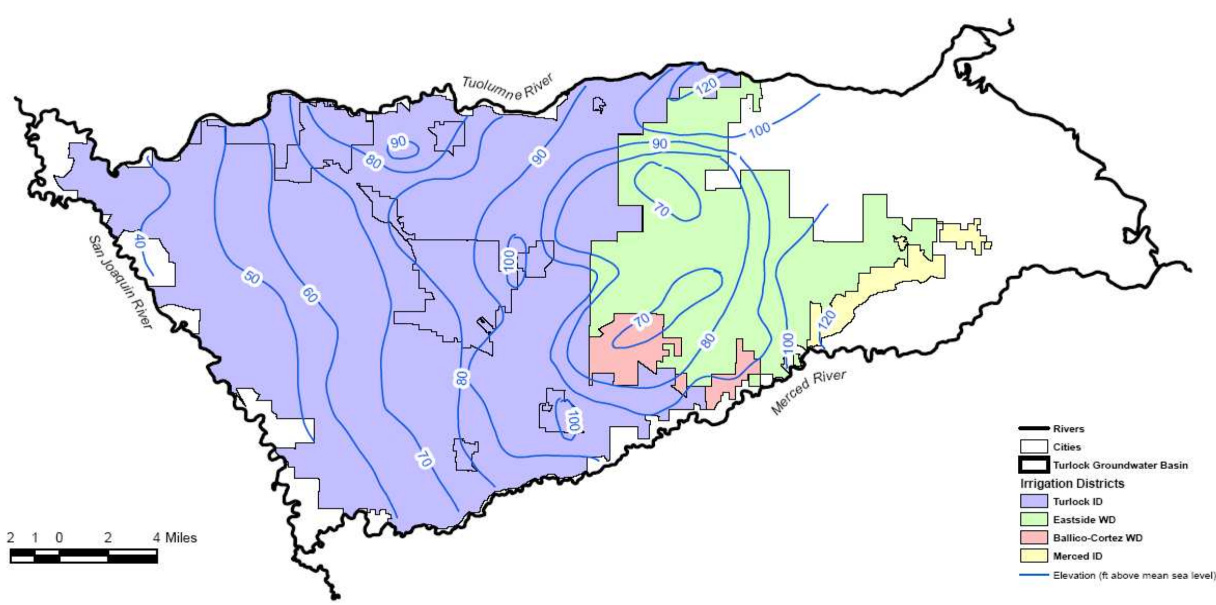

Figure 3.4. Groundwater Elevations - Spring 1986 (TGBA, 2008).

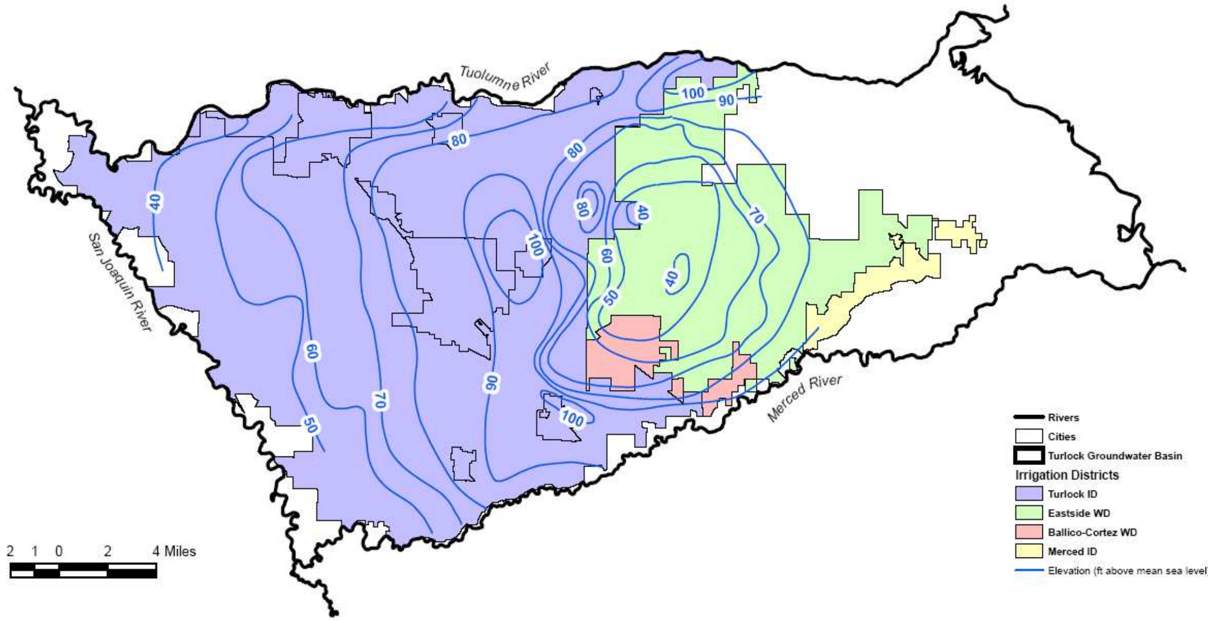

Figure 3.5. Groundwater Elevations - Spring 1998 (TGBA, 2008).

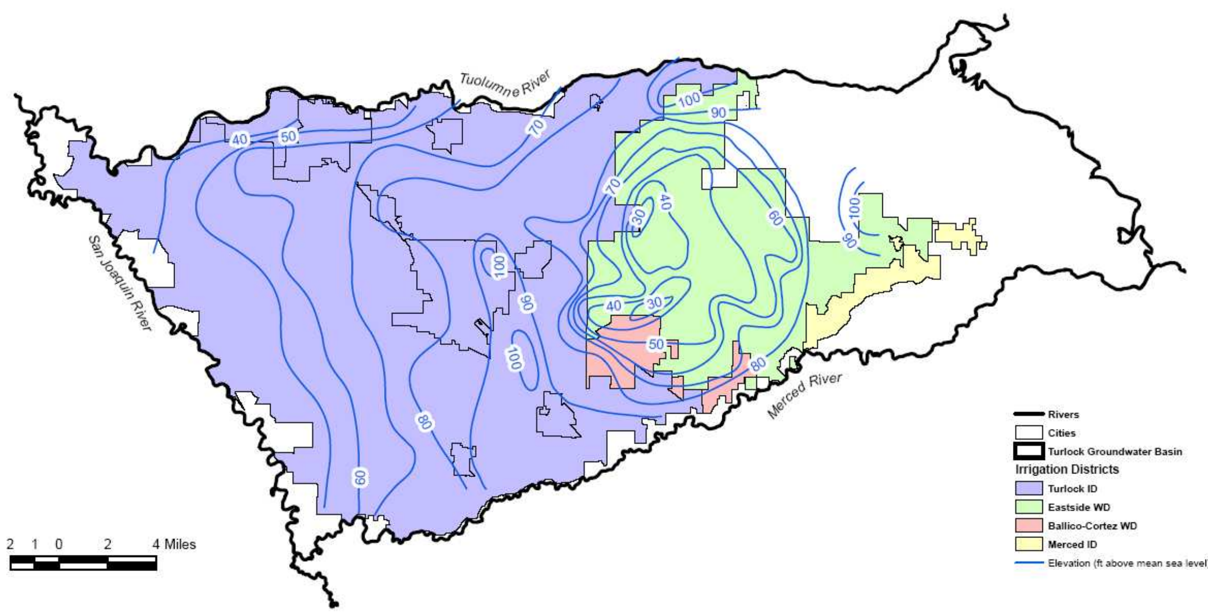

Figure 3.6. Groundwater Elevations - Spring 2005 (TGBA, 2008).

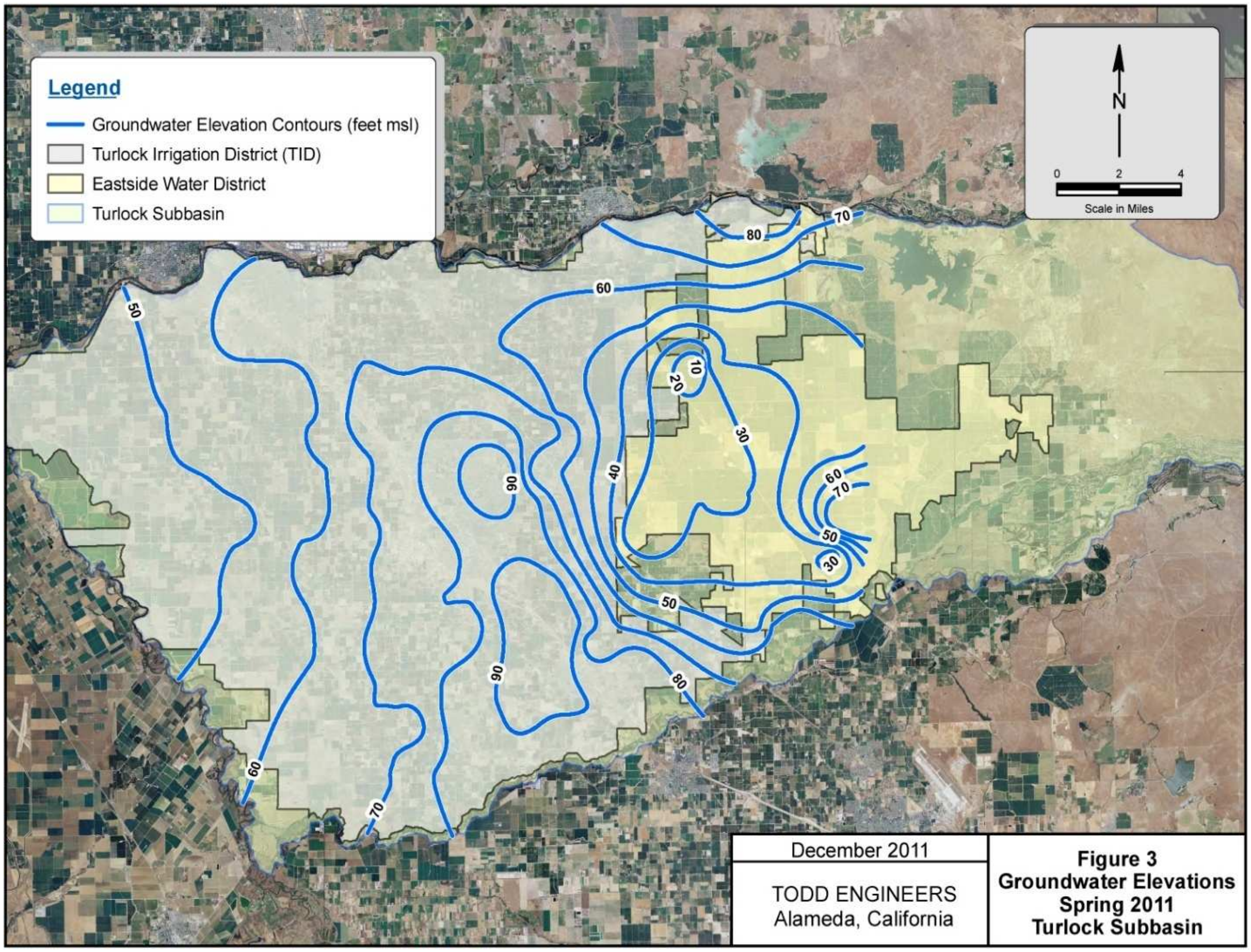

Figure 3.7. Groundwater Elevations - Spring 2011 (Todd Engineers, 2011).

TID adopted the updated Turlock Groundwater Basin Groundwater Management Plan on March 18, 2008, representing the lands in its service area that are outside of the boundaries of the local municipalities. The Groundwater Management Plan is provided on CD in Appendix B. Following the update of the Groundwater Management Plan in 2008 by TID and other local public agencies, efforts have been continued to monitor and evaluate groundwater conditions and to determine whether additional management actions should be considered.

TGBA applied for Local Groundwater Assistance (LGA) grant from the Department of Water Resources in 2012. The grant, if awarded, would use well logs and other available information to characterize the aquifer parameters and groundwater levels in areas to the east of Eastside Water District, where groundwater conditions remain unknown (Figure 3.7). The information gained would also be used to develop an updated groundwater model to evaluate the impacts to Basin water supplies if agricultural development, and groundwater pumping in these areas, without access to surface water, continues. Earlier studies, completed without the benefit of this additional data, suggest that additional agricultural development on the eastern side of the basin has the potential to significantly impact groundwater availability. In the study, even if some community water systems began to use surface water supplies from the Tuolumne River (as described in Section 4.5.4), groundwater levels would decline, particularly in dry years (Timothy J. Durbin, Inc. 2008).

3.2.1.1 Conjunctive Management

TID's conjunctive management program is designed to encourage irrigators to draw from surface water supplies during periods of normal and above normal reservoir storage. Surface water from the Tuolumne River, applied within the TID via flood irrigation, is the primary source of groundwater recharge within the Basin. Use of surface water during normal and wetter years recharges the aquifer, enabling TID to rely more heavily on groundwater during years when surface supplies are below normal. During dry years TID increases the volume of groundwater pumped into the distribution system from rented and drainage wells to supplement surface water supplies. For example, in the 1976-1977 and 1987-1992 droughts, TID rented large numbers of Improvement District (ID) and private wells to supplement supplies from TID-owned wells. Table 3.5 shows that, on average, TID pumped approximately 24,000 more acre-feet of groundwater through rented wells and drainage pumping in dry years than in normal years between 1991 and 2011.

Sustained use of surface water for irrigation is a key component of TID's conjunctive management of surface water and groundwater supplies. The TID water balance indicates that over the period from 1991 to 2011 net groundwater recharge, including deep percolation of precipitation, ranged from a low of 0.7 AF per acre on average during dry years to a high of 1.3 AF per acre on average during normal years. Table 3.6 provides a summary of net recharge within TID. These results show the importance of continuing irrigation with surface water to maintain groundwater storage and water supplies in drier years. TID's tiered volumetric pricing structure for surface water (described in Section 2.7) is designed to encourage growers to use available surface water supplies to provide appropriate in-lieu and direct groundwater recharge. Having two rate schedules, one for normal or wetter years and one for dry years, provides different pricing signals between normal and dry water year types. This pricing encourages the use of available surface water supplies in normal and wetter years. In dry years, conservation of limited surface water supplies is encouraged, and additional revenue to recover increased pumping costs is obtained. However, even in dry years, surface water is priced competitively compared to private groundwater pumping. An important aspect of TID's conjunctive management strategy includes setting the price of TID water appropriately to discourage growers from becoming permanently reliant on groundwater.

Table 3.6. Summary of TID Net Recharge.

Period	Statistic	Net Recharge (AF/acre)		
		Seepage and Irrigation	Precipitation	Total
2007-2011	Average	0.7	0.3	1.0
	Minimum	0.3	0.1	0.5
	Maximum	1.0	0.5	1.5
1991-2011	Overall Average	0.7	0.4	1.1
	Normal Year Average	0.8	0.5	1.3
	Dry Year Average	0.5	0.2	0.7

During the period from 1991 to 2011, the TID water balance, described in Section 4, shows that for lands receiving TID deliveries, on average 82 percent of the water supply was surface water from the Tuolumne River with 16 percent coming from groundwater and 2 percent from other sources (Table 3.2). In years with a full allotment, when more surface water was available, these percentages, on average, were 84 percent surface water, 15 percent groundwater, and 2 percent other supplies[6]. In years with less than a full allotment, the average percentages were 79 percent surface water, 19 percent groundwater, and 2 percent other supplies.

In 1991, an extremely dry year, the percentage of water supplied by pumping was even greater (23 %). TID pumped even more in past dry cycles (1976-1977) and (1987-1988). Unfortunately, the high rates of groundwater extraction in 1977 (67 %) and 1988 (56 %) can no longer be achieved because of the decline in groundwater levels, particularly along TID's eastern boundary.

In response to increased volumes of groundwater used in the 1976-1977 and the 1987-1992 droughts, TID developed a drought conjunctive management plan. One outcome of the plan is improved management of groundwater pumping within TID. Despite improved management of water resources within TID, the ability to sustain groundwater supplies beneath the TID service area is hindered by substantial groundwater pumping for irrigation of more than 74,000 acres of crops east of TID in an area with no available surface water supply. This pumping, along with the small area of groundwater-only irrigation within TID, continues to contribute to the decline in water levels of the aquifers underlying TID, particularly during periods of drought. More efficient irrigation techniques being used in the groundwater-irrigated areas has helped lessen the impact of agricultural expansion on groundwater levels; however, this may be counteracted by the additional agricultural development continuing to expand eastward within the Basin, and to lesser extent, by the increasing use of pressurized irrigation systems in the eastern portion of TID, which tend to produce less deep percolation than traditional surface irrigation methods.

3.3 OTHER WATER SUPPLIES

There is growing use of recycled water within TID. Categories of recycled water identified within TID are subsurface drainage, tailwater, spill recovery, and recycled wastewater (Table 3.7). For the period of 1997 through 2011, an average of approximately 4,700 AF per year of recycled wastewater from the City of Modesto, City of Turlock and Hilmar Cheese has been utilized on approximately 1,900 acres within the TID boundaries to irrigate forage crops. Over the period 2007 to 2011, the average volume of recycled water used for irrigation was 5,200 AF per year.

The Harding Drain is a multi-use facility; transporting treated effluent from the City of Turlock, urban runoff, drainage from lands adjacent to the drain, groundwater accretions and spilled canal water, however the percentages of each are unknown. Historically, TID utilized water from the Harding Drain to supplement supplies in Lateral 5 ½. However, water reuse regulations restricted TID's ability to recapture those flows for a time until the City of Turlock implemented tertiary treatment. TID was able to resume the reuse from the Harding Drain in July 2008. From

[6] Percentages do not add up to 100 percent when reported to the nearest whole percentage point due to rounding error. To the nearest 0.1 percent, the averages are 83.5 percent. 14.5 percent, and 2.0 percent for surface water, groundwater, and other supplies, respectively.

Table 3.7. Summary of TID Other Water Supplies[1].

Year	Allotment (inches)[2]	Subsurface Drainage[3]	Tailwater to Canals[4]	Spill Recovery[5]	Treated Waste-water[6]	Total Other Supply	
						Acre-Feet	Percent of Total Supply
2007	36	6,680	1,628	-	5,243	13,551	2%
2008	40	5,379	1,403	1,370	5,596	13,748	2%
2009	48	5,284	1,075	2,428	5,233	14,020	2%
2010	48	7,689	850	2,020	5,550	16,109	3%
2011	48	9,978	951	2,659	4,415	18,003	3%
2007-2011	Average	7,002	1,181	1,695	5,207	15,086	2%
	Minimum	5,284	850	-	4,415	13,551	2%
	Maximum	9,978	1,628	2,659	5,596	18,003	3%
1991-2011	Overall Average	6,145	1,500	404	3,727	11,776	2%
	Normal Year Average	6,485	1,443	547	3,705	12,179	2%
	Dry Year Average	5,592	1,594	171	3,764	11,121	2%

1 Irrigation season values only.
2 Depth of water in inches available equally to each acre of land.
3 Subsurface drainage is estimated based on flow meters and power records.
4 Estimated based on survey of tailwater producing lands.
5 Estimated based on flow measurements.
6 Reported by entities providing water for recycling.

July of 2008 until the end of the irrigation season, 1,370 AF of water was reused from the Harding Drain. For the period from 2009 to 2011, an average of 2,370 AF of water per year was reused.

Some tailwater enters TID canals indirectly through drainage channels that are intercepted by the distribution system. This recovered tailwater is blended with water in the canals and utilized to the greatest extent possible. Based on the TID water balance, it is estimated that an average of approximately 1,200 AF of tailwater flows into the TID distribution system each year (2007-2011).

In the 1990's growers began installing subsurface drainage systems to help control shallow groundwater. These drains discharge into the TID canals where the water is blended with water in the canals and utilized to the greatest extent possible. Based on the TID water balance, it is estimated that subsurface drainage systems pump an average of 7,000 AF of water per year into TID canals (2007-2011).

Additionally, some long improvement district pipelines were designed and constructed so they terminate at a TID canal in order to recover undelivered irrigation water where it can be used for irrigation delivery downstream. This undelivered water originates from fill up and run down water, or when growers choose to not take a delivery. The volume of water that is recovered in this manner has not been quantified independently due to its intermittent nature, but is reflected in the water balance closure to determine deliveries to farms.

Another component of recycled water use is recycling of dairy nutrient water through land application. TID assists growers who wish to receive nutrient water by allowing dairies to transport nutrient water through improvement district conveyance structures. This recycling of dairy runoff reduces discharge, enables growers to utilize the nutrient water as fertilizer for forage crops, and provides water for irrigation. This component is difficult to estimate independently and is not currently included in the water balance.

Similarly, TID supports the practice of reusing industrial process water from Hilmar Cheese Company by allowing Hilmar Cheese to transport the process water through improvement district conveyance structures. Using the existing improvement district facilities in this manner enables Hilmar Cheese to apply the process water for agricultural use, and the growers on those facilities to benefit from the water supply year-round, including the non-irrigation season when TID supplied irrigation water isn't available. This type of reuse has increased over time as the Hilmar Cheese facility has diversified and expanded. Between 2007 and 2011, approximately 1,400 AF of process water was recycled per year, on average.

3.4 SOURCE WATER QUALITY MONITORING PRACTICES

TID actively monitors water quality of both canal and well waters through samples collected under several different water quality programs. Some of these programs, such as the quarterly agricultural suitability monitoring are voluntary and self-directed while other programs, such as the Aquatic Pesticide Permit are required regulatory programs.

3.4.1 Agricultural Suitability Monitoring

Quarterly agricultural suitability (or Ag Suitability) monitoring is performed at Turlock Lake and spill locations during the irrigation season to monitor long-term water quality trends in the TID system. Samples at spill locations are not representative of source water; however since they are at the bottom end of the distribution system they do represent a possible worst case scenario of quality of waters delivered to growers. The data is provided to growers upon request.

Ag suitability monitoring includes analysis for a standard "ag panel" (sodium, calcium, magnesium, carbonate, bicarbonate, chloride, phosphorus, potassium, nitrate, sulfate, boron, TDS, pH, EC and adjusted sodium adsorption ratio {adj. SAR}). Data gathered by TID for agricultural suitability monitoring is not conducted pursuant to the rigorous quality assurance and quality control standards established for water quality regulatory programs. The data is not intended for that purpose. The results, however, do provide the District and its customers with general information regarding the quality of water within the distribution system.

3.4.2 Well Quality Monitoring

TID has sampled most of its own wells plus the rented wells used for irrigation supply. The samples are analyzed for the same "ag panel" listed above. Data gathered over the years shows that the water quality from the wells does vary, but not significantly from year to year. As funds allow, District drainage and rented wells are sampled for water quality to maintain a good understanding of the quality of groundwater entering the distribution system. Additionally, if there are concerns regarding water quality in an area, or from a particular well, samples are taken to confirm the current conditions. During droughts, one of the objectives of TID's conjunctive management program is to provide a water supply that satisfies irrigation demands in terms of quantity, timing of deliveries, and water quality. To this end, the selection process for wells used to supplement water supplies includes consideration of well salinity levels. WDOs are provided pump salinity levels, and utilize that information to provide the growers with the best water quality, including minimizing the use of wells with elevated salinity levels when it could affect germination of crops.

TID also collects an "ag panel" sample during the formation of a pump Improvement District. As a general policy, if the electroconductivity of the new well is above 1.5 dS/m (or about 1,000 ppm TDS), TID staff recommends that the Improvement District not be formed.

3.4.3 Subsurface Drain Monitoring

Starting in the 1990s, growers began installing subsurface drainage systems to help control shallow water table levels. Discharge from these subsurface drains enters the TID distribution system and becomes a part of the overall water supply. TID samples 32 subsurface drain discharges on a quarterly basis. The samples are analyzed for the same "ag panel" listed under *Agricultural Suitability Monitoring* above. The data are provided to the Improvement Districts and growers are encouraged to implement on-farm measures to improve water quality should it not meet TID's water quality standards.

3.4.4 Real-time Canal Monitoring

In 2005 TID began installing water quality telemetry to better understand the quality of water within the canal/drainage system. TID has installed YSI 600XL multi-parameter water quality sondes at 15 canal spill and drain locations. These sondes measure Electrical Conductivity (EC), and temperature on a real-time basis. The data is uploaded into TID's SCADA system where it can be viewed by staff. The data is useful in determining how canal water quality changes as a result of different operational scenarios.

3.4.5 Irrigated Lands Regulatory Program Monitoring

Between 2004 and 2010 TID performed additional water quality sampling and reporting in compliance with the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Irrigated Lands Regulatory Program). During that time, TID sampled three spill locations twice during the irrigation season and two spill locations twice during a storm event. Samples are collected and analyzed for general water quality parameters (pH, EC, DO, temperature, turbidity, TDS, TOC, TKN, phosphorus and potassium) as well as the active ingredients of any pesticides or herbicides utilized by TID along the canals, which included up to eleven active ingredients from herbicides used for terrestrial weed control purposes.

Beginning in 2011, TID joined the East San Joaquin Water Quality Coalition (ESJWQC) for coverage under the Irrigated Lands Regulatory Program (ILRP). The ESJWQC represents growers throughout TID service area as well as other areas on the eastern side of the San Joaquin River. The ESJWQC has an elaborate monitoring program which includes a wide variety of constituents, sampled in a number of local drains and canals. The program is designed to rotate throughout the watershed, and as a result, the sampling locations and constituents are subject to change. Additionally, the ILRP is in the process of being revised. A new Waste Discharge Requirements (WDR) for the ESJWQC is currently under review, and could be finalized in late 2012. The new permit, when issued, will significantly change the ILRP, bringing groundwater monitoring and protection into the program for the first time. As members of the ESJWQC, TID continues to coordinate with ESJWQC staff regarding water quality issues. To facilitate this process, a TID staff member serves on the ESJWQC Board of Directors. Information from the new WDR will provide additional information regarding surface and groundwater quality in the TID service area.

3.4.6 Aquatic Pesticide Permit

TID applied for and received coverage for its applications of Magnacide-H and endothall-based herbicides under the Statewide General NPDES Permit for Aquatic Pesticides. Both the Magnacide-H and endothall products are aquatic herbicides for the control of submerged aquatic weeds and algae. As part of the permit, monitoring is required for general water quality parameters (pH, EC, DO, temperature and turbidity) as well as the active ingredient of the permitted herbicide (in this case, acrolein or endothall). The Statewide General NPDES Permit is in the process of being revised by the State Water Resources Control Board (SWRCB). Once the new permit is approved, TID will make any adjustments to its program necessary to comply with the new requirements.

3.4.7 Water Quality Monitoring Results

The surface water supply for TID originates as snowmelt from the Sierra Nevada Mountains and is of very high quality. Quarterly water quality monitoring performed at Turlock Lake as part of TID's Ag Suitability Monitoring shows that water diverted from the Tuolumne River has an average total dissolved solids (TDS) measurement of 38 parts per million (ppm), nitrates at less than1 ppm, phosphorus less than 0.04 ppm and potassium of 1 ppm. This high quality water poses no restrictions for irrigation. However, some growers do need to add gypsum to heavier soils to overcome infiltration problems associated with such low TDS water.

Sampling of TID owned drainage wells and the rented wells show that some wells provide water with elevated TDS levels. A few wells show TDS levels that exceed 2,000 ppm. The average of all of the groundwater TDS measurements made by TID is 712 ppm. The pumped groundwater is mixed with surface water in the distribution system, resulting in irrigation water of acceptable quality. Groundwater salinity generally increases from east to west across TID and with depth so that in the western third of TID, wells that go below the Corcoran Clay can be too salty for normal use.

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4 Water Balance

4.1 INTRODUCTION

This section describes the various uses of water within TID, followed by a detailed description of TID's water balances for key accounting centers within the District. The water balance presented in this AWMP covers the most recent 5 year period from 2007 through 2011. This period was selected to utilize the highest quality data available and to support the development of useful conclusions regarding TID's current operations. To understand TID's conjunctive management approach to water resources management, it is useful to take a longer view to identify differences between wet and dry years. Consequently, averages from 1991 through 2011 are referenced as well. The water balance quantifies all significant inflows and outflows of water to and from the TID service area during the irrigation season. The irrigation season varies from year to year based on water needs, but approximately covers the period from March through October.

The water uses and water balances are discussed in relation to hydrologic conditions within TID, which vary from year to year. Key hydrologic drivers of water management in a given year include available surface water supply based on Don Pedro Reservoir inflows; precipitation within the TID service area, and evaporative demand.

4.2 WATER BALANCE OVERVIEW

The TID water balance includes separate accounting centers for the TID distribution system and the surface water irrigated lands served by TID. A total of twenty-one individual flow paths are quantified as part of the water balance. A schematic of the water balance structure is provided in Figure 4.1.

In general, flow paths are quantified on a monthly basis for the irrigation season (March – October). For each accounting center, all but one flow path is determined independently based on measured data or calculated estimates, and the remaining flow path is then calculated based on the principal of conservation of mass (Equation 4-1), which states that the difference between total inflows and outflows to an accounting center for a given period of time is equivalent to the change in stored water within that accounting center. Over the course of a year, it is assumed that the change in storage is zero (Equation 4-2).

$$\text{Inflows} - \text{Outflows} = \text{Change in Storage (monthly time step)} \qquad [4\text{-}1]$$

$$\text{Inflows} - \text{Outflows} = 0 \text{ (annual time step)} \qquad [4\text{-}2]$$

The flow path that is calculated using Equation 4-2 is referred to as the "closure term" because the mass balance equation is solved or "closed" for the unknown quantity. The closure term is selected based on consideration of the availability of data or other information to support an independent estimate as well as the volume of water representing the flow path relative to the size of other flow paths. Generally speaking, the largest, most uncertain flow path is selected as the closure term.

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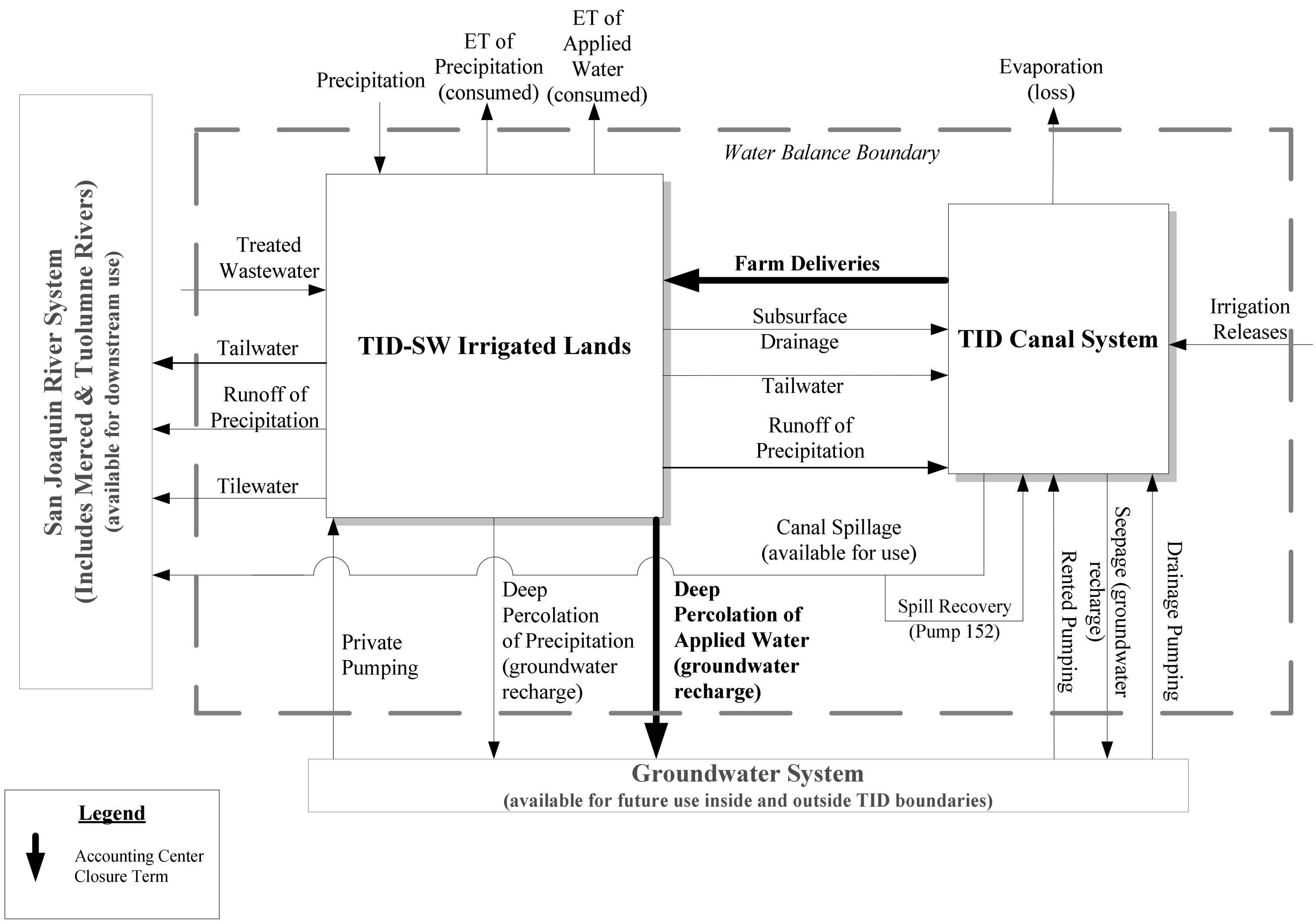

Figure 4.1. TID Water Balance Structure.

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4.3 FLOW PATH ESTIMATION AND UNCERTAINTY

Individual flow paths were estimated based on direct measurements or based on calculations using measurements and other data. As described previously, those flow paths not estimated independently were calculated as the closure term of each accounting center.

For the TID distribution system accounting center, farm deliveries were calculated as the closure term. Farm deliveries were selected because of inaccuracies inherent in TID delivery measurement devices (see the water delivery measurement discussion in the preceding section), and because farm deliveries represent the largest outflow from the distribution system, a highly accurate aggregated value can be obtained from the water balance.

For the farmed lands accounting center, deep percolation of applied water was calculated as the closure term. Deep percolation of applied water was selected because it is a relatively large flow path and nearly impossible to estimate otherwise.

The results of the water balance for each flow path are reported with a high level of precision (nearest whole acre-foot) that implies a higher degree of accuracy in the values than is actually justified. While a detailed uncertainty analysis has not been conducted to assess potential error in the data and computed values, an estimated percent uncertainty (approximately equivalent to a 95 % confidence interval) in each measured or calculated flow path has been estimated. Then, based on the relative magnitude of each flow path, the resulting uncertainty in each closure term can be estimated by assuming that errors in estimates are random (Clemmens and Burt 1997). Errors in estimates for individual flow paths may cancel each other out to some degree, but the net error due to uncertainty in the various estimated flow paths is ultimately expressed in the closure term.

Table 4.1 lists each flow path included in the water balance, indicating which accounting center(s) it belongs to, whether it is an inflow or an outflow, whether it was measured or calculated, the supporting data used to determine it, and the estimated uncertainty, expressed as a percent. As indicated, estimated uncertainties vary by flow path from 3 percent to 35 percent of the estimated value, with uncertainties generally being less for measured flow paths and greater for calculated flow paths. The estimated uncertainty of each closure term, calculated based on the concept of propagation of random errors as described above, is also shown for each closure term.

As indicated, the estimated uncertainty in farm deliveries is 5 percent. This uncertainty is relatively small due to the relatively low uncertainty in system inflows from Turlock, which represent the largest flow path in the distribution system balance. The estimated uncertainty in deep percolation of applied water is 39 percent. Despite appreciable uncertainty in some flow path quantities, the water balance provides useful insights into TID's water management.

4.4 HYDROLOGIC YEAR TYPES FOR EVALUATION OF WATER MANAGEMENT

Development of a multi-year water balance allows for evaluation of water management impacts of surface water supply variability, precipitation variability, and other changes in the hydrology of TID and its surrounding area over time. Specifically, a multi-year water balance that includes both dry and normal years is essential to evaluate and plan for conjunctive management as

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Table 4.1. TID Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty.

Accounting Center	Flowpath Type	Flowpath	Source	Supporting Data	Typical Volume (AF)[1]	Estimated Uncertainty (percent)[1]
Distribution System	Inflows	Irrigation Releases	Measurement	Broad-crested weir measurement site just downstream of Turlock Lake	495,000	3%
		TID Drainage Pumping	Measurement	TID drainage well pump power use measurements	46,000	20%
		TID Rented Pumping	Measurement	TID rented well pump power use measurements	38,000	20%
		Subsurface Drainage Reuse	Measurement	Flow meter where reliable records available, remainder based on power use	7,000	7%
		Tailwater to Canals	Calculation	Estimated as a percentage of deliveries to the specific parcels identified as draining to canals for 2009-2011.	1,200	35%
		Spill Recovery	Measurement	Pump 152 power use	1,700	20%
	Outflows	**TID Farm Deliveries**	**Closure (Distribution System)**	**Difference of total inflows and measured/estimated outflows for Distribution System accounting center**	**499,000**	**5%**
		Canal Seepage	Calculation	NRCS soils data, published seepage rates by soil type, estimated wetted area, estimated wetted duration, representative ponding tests.	37,000	35%
		Operational Spillage	Measurement	TID operational spill measurements, predominately Cipoletti weirs	52,000	9%
		Canal Evaporation	Calculation	CIMIS reference ET (Denair CIMIS station), estimated evaporation coefficient, estimated wetted surface area	1,500	30%
Irrigated Lands	Inflows	**TID Farm Deliveries**	**Closure (Distribution System)**	**Difference of total inflows and measured/estimated outflows for Distribution System accounting center**	**499,000**	**5%**
		Private Groundwater Pumping	Calculation	Estimated groundwater only area, average TID ET_{aw} and CCUF	19,000	20%
		Treated Wastewater	Measurement	Measurements received from City of Modesto, Hilmar Cheese, City of Turlock, and Treated Wastewater prorated based on days in the irrigation season	5,200	10%
		Precipitation	Calculation	Quality-controlled precipitation from Denair CIMIS station, TID cropped area	49,000	20%
	Outflows	Crop ET of Applied Water (ET_{aw})	Calculation	CIMIS reference ET, estimated crop coefficients, cropped area by crop, root zone simulation model to divide total ET into applied water and precipitation components	356,000	15%
		Tailwater to Reuse and to Rivers	Calculation	Estimated as a percentage of deliveries to the specific parcels identified as draining to canals for 2009-2011.	2,900	35%
		Deep Percolation of Applied Water	**Closure (Farmed Lands)**	**Difference of total inflows and measured/estimated outflows for Farmed Lands accounting center applied water balance**	**156,000**	**39%**
		TID Subsurface Drainage Reuse and to Rivers	Measurement	Flow meter where reliable records available, remainder based on power use	7,900	7%
		Crop ET of Precipitation (ET_{pr})	Calculation	CIMIS reference ET, estimated crop coefficients based on SEBAL 2009 analysis, cropped area by crop, root zone simulation model to divide total ET into applied water and precipitation components	53,000	15%
		Deep Percolation of Precipitation	Calculation	Root zone simulation model, NRCS soils characteristics, CIMIS precipitation data	27,000	25%
		Runoff of Precipitation	Calculation	Root zone simulation model, CIMIS precipitation data, NRCS curve number method	1,200	35%
		Change in Storage of Precipitation	Calculation	Root zone simulation model, negative values indicate a net decrease in stored precipitation due to consumption or deep percolation	-32,000	30%

[1] Typical Annual Volume and Closure Uncertainty Estimated based on 2007-2011 average irrigation season volume. Due to rounding inflows and outflows may not be exactly equal (see Tables 4.8 and 4.9 for detailed water balance results).

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practiced by TID. This multi-year water balance also supports the EWMP "planned conjunctive use of surface water and groundwater", that is discussed in Section 6. To support review and interpretation of water uses and overall water balance results over time, TID surface water allotments, total calendar year precipitation, and total water year reference evapotranspiration (ET_o) are presented, and year types are assigned.

As discussed previously, TID has a reliable source of water from Don Pedro Reservoir through a variety of water rights on the Tuolumne River. TID growers have received a full allotment in 13 of the last 21 years. During the 2007 to 2011 period, a partial allocation was provided in 2007 and 2008, with full allocations in the remaining three years.

Reduced inflows into Don Pedro Reservoir due to reduced precipitation in the watershed typically correspond to years with reduced precipitation and increased evaporative demand in the TID service area. Based on the TID allotment provided to growers, the years 1991 to 2011 have been assigned to normal or dry year types for purposes of discussion of water uses in TID over time and the corresponding water balances. As described in Section 3, "dry" years are those years when the allotment was less than 48 inches, and "normal" years are those years with a 48 inch allotment. These year type classifications are for this analysis only, and not meant to correspond with water year classifications used for regulatory or other purposes. The allotment, calendar year precipitation, reference ET and the year types by year, from 2007 to 2011, are listed in Table 4.2.

Table 4.2. 2007 to 2011 TID Allotment, Water Year Precipitation, and Irrigation Season ET_o, and Hydrologic Year Type.

Year	Irrigation Season Start Date	Irrigation Season End Date	Number of Days	TID Allotment, inches	Year Type	Precipitation, in	ET_o, in
2007	16-Mar	24-Oct	223	36	Dry	8.8	46.9
2008	13-Mar	7-Oct	209	30	Dry	9.1	44.3
2009	20-Mar	21-Oct	216	48	Normal	7.5	44.3
2010	18-Mar	31-Oct	228	48	Normal	14.7	44.4
2011	17-Mar	2-Nov	231	48	Normal	17.2	44.0
2007 – 2011 Average						11.4	44.8
2007 – 2011 Minimum						7.5	44.0
2007 – 2011 Maximum						17.2	46.9
1991 – 2011 Overall Average						13.1	43.7
1991 – 2011 Normal Year Average						14.6	42.9
1991 – 2011 Dry Year Average						10.1	44.7

Over the 1991 to 2011 time period, March to October ET_o was least for normal years, averaging approximately 43 inches. In the 5-year period from 2007 to 2011, average irrigation season ET_o has been approximately 45 inches. The dry years of 2007 and 2008 had a partial allotment, while 2009, 2010 and 2011 had full allotments. Water year precipitation (October through September) in the TID service area tends to be less in dry years as compared to normal years, with an average between 1991 and 2011 of approximately 10 inches and 15 inches for dry and normal years, respectively.

In addition to having reduced surface water supplies, dry years also tend to experience below normal precipitation within the TID service area as well as increased evaporative demand, resulting in increased crop irrigation requirements. Thus, in dry years TID faces increased irrigation demands at a time when reduced surface water supplies are available to meet crop requirements. As a result, in dry years the availability of groundwater to supplement reduced surface water supplies is important to meet local crop water requirements.

4.5 WATER USES

As described in Sections 2 and 3, the District co-owns Don Pedro Reservoir with MID. The reservoir is outside of TID's service area and is managed by TID and MID for water supply, power generation, recreation, and flood control purposes. TID supplies irrigation water for agriculture. TID also provides domestic drinking water (in conjunction with MID) for the community of La Grange. These and other water uses within TID's service area, as well as uses related to TID's operations are described in greater detail in the remainder of this section.

4.5.1 Agricultural

The TID service area covers a gross area of 197,261 acres with approximately 157,800 irrigable acres that have the ability to receive the TID surface water. Between 2007 and 2011 an average of 143,160 assessed acres received surface water from TID. This translates to an average of 134,571 irrigated acres when an estimate of field roads and other small non-irrigated areas are accounted for.

The TID service area climate and soils are suitable for a wide variety of crops (more than 40 different crops were grown during the 21 years from 1991 through 2011). Table 4.3 lists the types of crops grown in the TID irrigation service area, along with a summary of acreages planted in each crop between 2007 and 2011 and over the 1991 to 2011 period for both normal years[7] and dry years. The minor differences in average acreages for normal and dry years reflect the high water supply reliability achieved by TID's conjunctive management approach to water resources management. This high water supply reliability is also reflected in the large areas of permanent crops and crops supplying local dairies that require a steady water supply year after year. The values in Table 4.3 represent irrigated acreages with double cropping included as a specific crop type. Thus, double counting of acres is avoided. For crops grown in the TID service area, growing season evapotranspiration (ET) computed using the CIMIS reported reference evapotranspiration (ET_o) and University of California recommended crop coefficients (UC, Leaflets 21427 and 21428) are provided in Table 4.4.

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[7] Note that "normal" years, as described herein may include relatively wet years with respect to overall hydrology. As noted previously, for purposes of discussion, normal years refer to those years with a full 48-inch surface water allocation.

Table 4.3. Irrigated Area[1] of Crops Grown on Lands Receiving TID Surface Water.

Crop	1991-2011 Normal Year Average	1991-2011 Dry Year Average	1991-2011 Average	2007-2011 Average
Alfalfa	13,405	15,452	14,185	9,738
Almonds	43,279	41,870	42,742	44,618
Apples	781	790	785	560
Apricots	28	36	31	2
Beans	621	661	636	200
Beets	1	0	0	0
Berries	19	40	28	2
Carrots	1	9	4	0
Cherries	365	329	351	468
Christmas Trees	2	3	2	0
Citrus	9	9	9	6
Clover	475	539	499	243
Corn	9,259	8,653	9,028	10,508
Double - Other	10,038	9,151	9,700	9,098
Eggplant	1	2	2	0
Garden	76	67	73	50
Grain	145	106	130	15
Gypsophilia	53	60	56	0
Kiwi	29	53	38	15
Lawn	1,189	1,071	1,144	1,283
Melons	212	280	238	74
Oats	2,304	3,560	2,782	3,864
Oats/Corn	16,112	20,354	17,728	26,107
Olive	21	1	13	55
Onions	15	18	16	7
Other Crops	380	395	386	360
Other Trees	342	401	365	436
Pasture	10,107	10,959	10,432	7,610
Peaches	5,218	5,529	5,336	3,774
Pears	8	16	11	7
Peas	0	2	1	5
Plums	34	37	35	6
Pumpkins	93	95	94	75
Squash	23	19	21	0
Sudan	819	636	749	553
Sunflowers	1	15	7	3
Sweet Potatoes	1,975	1,638	1,847	1,422
Tomatoes	3	5	4	2
Unirrigated Forage/Corn[2]	11,159	6,286	9,303	6,992
Vineyard	2,992	2,990	2,991	1,683
Walnuts	4,763	4,915	4,821	4,842
Totals[3]	136,358	137,049	136,624	134,682

[1] Irrigated area estimated as 94 percent of assessed area (to account for farm roads and non-irrigated areas). Due to rounding of individual crop acres, totals may differ slightly from 94 percent of assessed area.
[2] Unirrigated (rainfed) forage followed by irrigated corn in a double cropped sequence.

Table 4.4. Growing Season (March through October) ET[1] in Inches for Crops Receiving TID Surface Water.

Crop	1991-2011 Normal Year Average	1991-2011 Dry Year Average	1991-2011 Average	2007-2011 Average
Alfalfa	38.36	40.47	39.16	39.58
Almonds	34.75	36.83	35.44	36.11
Apples	38.57	40.90	39.34	40.08
Apricots	34.75	36.83	35.44	36.11
Beans	23.55	24.36	23.82	25.40
Beets	33.98	35.56	34.51	35.58
Berries	21.20	21.92	21.46	22.78
Carrots	33.98	35.56	34.51	35.58
Cherries	38.57	40.90	39.34	40.08
Christmas Trees	42.26	45.01	43.19	43.71
Citrus	27.53	29.26	28.11	28.57
Clover	44.25	47.26	45.27	45.57
Corn	28.65	29.94	29.04	30.30
Double - Other	32.12	33.91	32.79	33.26
Eggplant	33.98	35.56	34.51	35.58
Garden	33.98	35.56	34.51	35.58
Grain	23.46	24.32	23.87	25.09
Kiwi	38.36	40.73	39.10	40.00
Lawn	37.98	40.51	38.83	39.18
Melons	25.33	26.34	25.77	26.80
Oats	23.46	24.32	23.87	25.09
Oats/Corn	39.20	41.33	39.94	40.62
Onions	36.34	38.24	37.08	37.41
Other Crops	23.55	24.36	23.82	25.40
Other Trees	35.31	37.24	35.93	36.89
Pasture	35.86	38.26	36.67	36.97
Peaches	34.74	36.83	35.44	36.11
Pears	34.74	36.83	35.44	36.11
Peas	26.66	27.57	27.01	28.14
Plums	34.74	36.83	35.44	36.11
Pumpkins	26.88	27.74	27.21	28.49
Squash	26.88	27.74	27.21	28.49
Sudan	25.38	25.86	25.47	28.07
Sunflowers	22.35	22.98	22.57	24.10
Sweet Potatoes	25.65	26.55	25.95	27.32
Tomatoes	33.98	35.56	34.51	35.58
Unirrigated Forage/Corn[2]	32.45	35.12	33.31	33.14
Vineyard	25.61	26.62	25.84	27.56
Walnuts	38.72	40.90	39.44	40.47

[1] Total ET derived from applied water and precipitation reduced to account for "bare spots and reduced vigor" to represent the total water consumed.

[2] Unirrigated (rainfed) forage followed by irrigated corn in a double cropped sequence.

Other uses of applied irrigation water include leaching of salts and frost protection for orchards and vineyards. These uses are limited. Due to the generally low salinity of TID irrigation water, the required leaching fraction is small for the crops grown in the District**.** Growers using groundwater of relatively higher salinity for irrigation could require leaching to maintain production for sensitive crops. Should the use of groundwater increase, leaching requirements would also be expected to increase, to the extent that groundwater salinity is greater than surface water salinity. Leaching requirements have not been estimated at this time. Similarly, frost protection may be necessary in certain circumstances. Frost protection is typically applied outside of the irrigation season and is provided through the use of private or ID wells. Frost protection has not been estimated at this time.

4.5.2 Environmental

There are no natural environmental resource delineations within the irrigation service area that are supported by TID diversions. However, the Federal Energy Regulatory Commission (FERC) license requirements for Don Pedro Reservoir include an extensive set of minimum instream flow release requirements that vary with the water year type. Instream flows and irrigation releases come from the Don Pedro Reservoir supplies. Releases to the Tuolumne River for environmental purposes therefore reduce the remaining supplies available for irrigation. In 1996, instream flow requirements were significantly increased. The annual volume of these flows ranges from 94,000 acre-feet in dry years to 301,000 acre-feet in wet years, up from 64,000 acre-feet and 123,000 acre-feet under the previous license requirements for dry and wet years, respectively. The TID contributes approximately 68 percent of these releases. Diversions for irrigation are made after the instream requirements are met. (Note: The FERC flow related dry and wet year distinctions described in this paragraph are based on regulatory requirements and are not related to other hydrologic water year descriptions included within this AWMP.)

During a 45-day period between October 15 and December 1 (e.g., October 17 through November 30), flow fluctuations in the Tuolumne River are minimized to protect fall-run Chinook salmon. For the period extending from October 15 through March 15, river flow changes are also subject to certain ramping rates to protect salmon, which can require additional flows.

Between 1999 and 2011, a portion of the years analyzed by this AWMP, TID also participated in the Vernalis Adaptive Management Plan (VAMP). VAMP was designed to test the effects of various 30-day pulse flows (as measured at Vernalis on the main stem of San Joaquin River) on out-migrating salmon smolts while the state and federal export pumps were operated at specified levels. Under the division agreement among the VAMP participants, TID contributed up to an additional 11,000 acre-feet of water each year depending upon the basin hydrology and designated targets.

4.5.3 Recreational

While there are recreational uses of TID diversions, there is no mandated supply dedicated to recreational use nor are the current recreational uses consumptive in nature.

The State of California operates a park at Turlock Lake (www.parks.ca.gov/?page_id=555). During the irrigation season, the water level in the lake is generally kept between water levels corresponding to 28,000 and 32,000 acre-feet of water to allow recreation along the shoreline and to assure steady deliveries to the distribution system. During consecutive dry years, in order to reduce seepage, TID may lower the operating lake level range corresponding to 22,000 to 27,000 acre-feet of water. By the end of the irrigation season, the lake is drawn down to provide stormwater capacity for the McDonald Creek watershed which drains into the Upper Main Canal and to allow for maintenance. The lake is used for duck hunting and other recreational uses conducive to the lower reservoir levels typical of the non-irrigation season.

4.5.4 Municipal and Industrial

TID, in conjunction with MID, operates the La Grange Domestic Water System serving 66 connections. Total water use is approximately 34 acre-feet per year, based on 2009 through 2011 data after the installation of water meters. This use is not included in the TID water balance as it occurs upstream of Turlock Lake. All other municipalities, industries, and small domestic uses of water in the TID service area rely on groundwater for their supply.

If groundwater remains the sole source of municipal water supply, it is expected that municipal groundwater use will increase over time. However, some of the local community water systems including those found in Hughson, Ceres, Turlock, and that portion of Modesto south of the Tuolumne River have for a number of years been studying the possibility of using TID surface water from the Tuolumne River in conjunction with existing groundwater supplies.

The uses of groundwater described in this section are not directly included in the Water Balance as they are not a part of the TID system. However, the municipal, industrial and small domestic use of groundwater does have a potential to influence the groundwater supplies available for irrigation purposes in the future.

4.5.5 Groundwater Recharge

Groundwater recharge is an important component of TID's conjunctive management strategy to achieve water supply reliability. As described in Section 3, TID is a leader in groundwater management. The majority of groundwater recharge within the basin occurs indirectly as a result of agricultural practices in the irrigation service area. The discussion of conjunctive management in Section 3 demonstrates how TID encourages the use of surface water supplies resulting in significant in-lieu groundwater recharge. Groundwater recharge that occurs within TID consists of passive seepage from TID canals and deep percolation of precipitation and applied irrigation water. This distributed, passive recharge provides a means to replenish the groundwater basin to the benefit of TID water users, communities within TID, and surrounding areas that share the groundwater resource. Estimates of indirect groundwater recharge of irrigation water from these sources were derived from the water balance analysis. Canal seepage was calculated based on soil characteristics along with estimated canal wetted perimeters, overall lengths, and wetting frequency. Deep percolation of irrigation water was calculated as the closure term of the TID-SW irrigated lands water balance accounting center. Seepage and deep percolation volumes for 2007 to 2011 are provided in Table 4.5, along with total recharge expressed as a volume and as a depth of water relative to the cropped area in each year.

Table 4.5. TID Total Groundwater Recharge.

Year	Year Type	Canal Seepage (AF)	Deep Percolation of Applied Water (AF)	Deep Percolation of Precipitation (AF)	Total Recharge (AF)	Total Recharge (AF/acre)
2007	Dry	37,519	158,683	8,189	204,391	1.5
2008	Dry	34,146	126,153	29,007	189,306	1.4
2009	Normal	36,860	149,004	39,213	225,077	1.7
2010	Normal	39,210	169,825	72,724	281,759	2.1
2011	Normal	39,340	178,694	70,687	288,721	2.2
2007-2011	Average	37,415	156,472	43,964	237,851	1.8
	Minimum	34,146	126,153	8,189	189,306	1.4
	Maximum	39,340	178,694	72,724	288,721	2.2
1991-2011	Overall Average	36,209	159,111	47,922	243,243	1.8
	Normal Year Average	36,542	165,257	61,487	263,286	1.9
	Dry Year Average	35,670	149,125	25,879	210,673	1.5

Total recharge between 2007 and 2011 ranged from approximately 189,000 AF to 289,000 AF per year, or from 1.4 AF to 2.2 AF per irrigated acre per year. On average, total recharge was estimated to be approximately 238,000 AF per year (1.8 AF/acre) for the period 2007 to 2011 and 243,000 AF per year (1.8 AF/acre) for the period 1991 to 2011. In the long term, total recharge is approximately 53,000 AF greater in normal years than dry years, on average. Approximately 15 percent of recharge originates from canal seepage, 65 percent of recharge originates from deep percolation of applied water, and 20 percent of recharge originates from deep percolation of precipitation.

TID relies on local groundwater supplies to supplement surface water deliveries, particularly in dry years. Additionally, urban areas, industrial, and private (both domestic and agricultural) pumpers within TID and the rest of the basin rely upon groundwater in all years to some extent. To enhance groundwater recharge within the basin, TID has been participating in a small, ten-year pilot groundwater recharge project with the Eastside Water District (see the EWMP section for a detailed description). These deliveries and subsequent recharge are not accounted for separately within the water balance, due to the small nature of the pilot project, but are included in the overall recharge estimates.

Net groundwater recharge was calculated by subtracting pumping volumes from total recharge volumes. Total pumping volumes include TID drainage pumping, TID rented well pumping, and private pumping volumes. Total recharge volumes include deep percolation of applied water and precipitation from farms as well as seepage from TID canals and from drains. Net recharge provides a measure of the net impact of TID's operations on groundwater storage volumes. Net recharge estimates for the study period are provided in Table 4.6.

Table 4.6. TID Net Groundwater Recharge.

Year	Year Type	Total Recharge (AF)	Groundwater Pumping (AF)	Net Recharge	
				AF	AF/acre
2007	Dry	204,391	120,345	84,046	0.6
2008	Dry	189,306	124,789	64,517	0.5
2009	Normal	225,077	109,621	115,456	0.8
2010	Normal	281,759	80,571	201,188	1.5
2011	Normal	288,721	81,304	207,417	1.5
2007-2011	Average	237,851	103,326	134,525	1.0
	Minimum	189,306	80,571	64,517	0.5
	Maximum	288,721	124,789	207,417	1.5
1991-2011	Overall Average	243,243	99,769	143,474	1.1
	Normal Year Average	263,286	90,373	172,913	1.3
	Dry Year Average	210,673	115,037	95,636	0.7

Net recharge ranged from approximately 65,000 AF to 207,000 AF per year between 2007 and 2011, or from 0.5 AF to 1.5 AF per irrigated acre per year. On average, net recharge was estimated to be approximately 135,000 AF per year (1.0 AF/acre) for the period 2007 to 2011 and 143,000 AF per year (1.1 AF/acre) for the period 1991 to 2011. In the long term, net recharge is approximately 77,000 AF greater in normal years than dry years, on average, or about 0.6 AF/acre. The computed net recharge is for the area within the water balance boundaries. Thus, seepage from Turlock Lake is not included in these net recharge values.

4.5.6 Transfers and Exchanges

During normal water supply years, surface water may be sold to lands outside but adjacent to the TID irrigation service boundary to reduce demands on groundwater supplies, providing in-lieu and direct groundwater recharge in the area of the cone of depression east of TID. Approximately 3,400 acres adjacent to, but outside, TID can purchase "surplus" water from TID. On average only 1,200 acres use about 2,100 acre-feet of water in years when surplus water is sold. No water is transferred into the TID service area from external sources.

During periods of surface water shortage, there is extensive use of internal water transfers to balance individual crop irrigation needs within the District. These types of transfers enable growers to make use of water unused on one parcel for the benefit of another parcel so long as both parcels are either owned by the same grower or under long-term lease. Sometimes the land supplying the transferred water has access to a deep well to meet the remaining crop needs. The requirement for long-term lease or rental arrangements prevents growers from leasing land during droughts simply to transfer the water allotment to other lands.

4.5.7 Other Water Uses

Other incidental uses of water within TID include watering of roads for dust abatement, agricultural spraying, and stock watering by TID water users. The volume of water used for such purposes is small relative to other uses and has not been quantified as part of this AWMP.

4.6 DRAINAGE

4.6.1 Spillage Recovery and Tailwater and Subsurface Drainage Reuse within TID

In TID's distribution system, operational canal spillage can occur at 15 locations (called canal spills) typically located at or near the terminal ends of the lateral canals. Six of the 15 canal spills terminate directly to local rivers. The remaining nine canal spills are to drains which are consolidated into three drains which spill to the local rivers. The drains carry a mixture of canal spillage, groundwater, tailwater, runoff from precipitation and urban runoff. Some of this drain water is captured for reuse.

The Ceres Main Canal runs north to south across approximately the center of the TID service area serving as an interceptor canal for spillage from the upper laterals that originate from the Turlock Main Canal (see the District Map in Appendix D). Additionally, some of the spill water from the Ceres Main Canal that is received by the Harding Drain is pumped from the drain and reused.

The City of Turlock also discharges treated municipal wastewater to the Harding Drain. Historically, TID would supplement surface water supplies in Lateral 5½ with water pumped from the Harding Drain. Due to the effluent discharges to the drain, the Regional Water Quality Control Board established regulatory restrictions and extensive reporting requirements for the reuse of any water taken from the Harding Drain, making it impractical for TID to recover spillage from the drain. Therefore, TID discontinued the practice. In 2006, the City of Turlock began putting their wastewater through a tertiary treatment process which removed the restrictions on reuse. TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. From 2009 to 2011, TID reused an average of 2,370 acre-feet per year from the Harding Drain. As described in Section 2.5, direct tailwater discharges from a field are not permitted into the TID distribution system. Some lands, mainly on the eastern side of TID, generate tailwater during irrigation. The majority of growers in this region have control structures to prevent irrigation tailwater from flowing back into the distribution system. Some tailwater is allowed to enter TID canals indirectly through the drainage channels into the distribution system. An inventory of TID lands begun in 2004 and last updated in early 2009 demonstrates that drain water, which includes tailwater mixed with other sources such as storm water, only comes from a small percentage of lands within TID (approximately 2,700 acres, or less than 2% of assessed acres). This water is blended with surface water supplies for delivery to TID growers. The amount of water generated from these lands is estimated and included in the water balance.

Tailwater can also be generated on an additional 8,200 acres within TID; however, this water is not intercepted by the distribution system and ultimately drains to natural waterways adjoining TID. TID growers have also installed recovery pumps which draw from local drains, to supplement irrigation supplies. These grower recovery pumps are not included under the TID facilities in Section 2 or in the water balance calculations.

Starting in the 1990s, growers began installing subsurface drainage systems to provide more uniform drainage. Discharge from these subsurface drains enters the TID distribution system and becomes a part of the water supply mix. During the irrigation season, this discharge is blended with canal water and utilized to the greatest extent possible as irrigation supply. During the non-irrigation season the subsurface drain water is passed through the distribution system and enters the rivers. Estimates of the subsurface drainage being reused or flowing to the rivers are included in the water balance.

In the non-irrigation season, the TID canals are drained of Tuolumne River surface water supplies. However, they are still used to convey subsurface drainage, drainage pumping, urban runoff from local communities, and storm water flows from east of the irrigation service area to the rivers. During the off-season, TID works with growers who wish to capture these flows, by boarding up drops, so long as it does not conflict with maintenance or other activities. This type of use is not significant, and is not considered a TID irrigation delivery. As such, it is not included specifically in the water balance.

4.6.2 TID Boundary Outflows

As previously discussed, TID owns only 18 miles of drains, and only a small percentage of TID irrigated land generates tailwater. TID has conducted a systematic inventory of the tailwater and storm drains that discharge to TID facilities. As described in more detail in Section 2.5, the inventory showed that the area with the ability to drain tailwater is small. As described above, a portion of this water may be recovered, with the remainder flowing to the river system. Between 2009 and 2011, tailwater discharge from the TID service area is estimated to have ranged between 2,600 and 3,300 AF per year with an average of 2,900 AF for the irrigation season[8].

Operational spillage from the TID distribution system is summarized in Table 4.7. Operational spillage ranged from approximately 23,000 AF to 87,000 AF per year between 2007 and 2011. On average, operational spillage was estimated to be approximately 52,000 AF per year (9% of total inflows to the distribution system) for the period 2007 to 2011 and 60,000 AF per year (10% of total inflows) between 1991 and 2011. In the long term, operational spillage is approximately 39,000 AF less in dry years than in normal years.

All surface water outflows from the TID service area are available for beneficial use by downstream users.

[8] Tailwater to rivers was not estimated prior to 2009 due to lack of available data.

Table 4.7. Summary of TID Operational Spillage.

Year	Year Type	Operational Spillage (AF)
2007	Dry	40,752
2008	Dry	22,504
2009	Normal	25,870
2010	Normal	81,968
2011	Normal	87,229
2007-2011	Average	51,665
	Minimum	22,504
	Maximum	87,229
1991-2011	Overall Average	60,019
	Normal Year Average	74,963
	Dry Year Average	35,735

4.7 WATER ACCOUNTING (SUMMARY OF WATER BALANCE RESULTS)

The TID water balance structure was shown previously in Figure 4.1. The water balance was prepared for two accounting centers: (1) the TID distribution system and (2) TID-SW irrigated lands. An accounting center representing the groundwater system is also included in Figure 4.1 to account for exchanges between the vadose zone and the aquifers underlying TID; however, a complete balance for the underlying aquifer is not calculated because not all subsurface inflows and outflows have been estimated. Tabulated water balance results for each accounting center are provided in Tables 4.8 and 4.9.

As depicted in Figure 4.1, extensive interconnection occurs among the accounting centers due to recapture and reuse of water by TID. Additional reuse occurs directly by the water users that is not accounted for in the water balance due to lack of data. These methods of water recovery and reuse result in higher levels of aggregate performance than would otherwise occur.

The water balance is presented on an annual time step for the irrigation season (approximately March through October) for the years 2007 through 2011. Summary results are provided for the 2007 to 2011 period as well as for the 1991 to 2011 period. Underlying the annual time step is a more detailed water balance in which all flow paths are determined on a monthly or more frequent basis. The winter months are excluded because the non-irrigation season water balance is influenced by unmeasured intercepted stormwater, and the information provided does not pertain to TID water management activities.

4.7.1 Distribution System Water Balance

Over the 2007 to 2011 period, the District distribution system (also referred to as the canal system) had total inflows from Turlock Lake ranging from 441,000 AF to 538,000 AF for the irrigation season with an average of 495,000 AF. For the 1991 to 2011 period, normal year

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Table 4.8. TID Distribution System Irrigation Season Water Balance Results.

Year	Allot-ment (inches)	Irrigation Season		Number of Days	Inflows (AF)								Outflows (AF)			Closure (AF)	Performance Indicators		
					Surface Supply	Groundwater Supply		Other Supply											
		Start Date	End Date		Irrigation Releases	TID Drainage Pumping	TID Rented Well Pumping	Sub-surface Drain-age	Tail-water to Canals	Spill Reco-very (Pump 152)	Runoff of Precipi-tation to Canals	Total Supply	Opera-tional Spillage	Evapo-ration	Irrigation Season Seepage	Farm Deliveries	Surface Water Supply Fraction [1]	Delivery Fraction [2]	Water Manage-ment Fraction [3]
2007	36	16-Mar	24-Oct	223	499,137	48,278	55,683	6,680	1,628	-	-	611,406	40,752	1,617	37,519	531,518	0.83	0.87	0.997
2008	30	13-Mar	7-Oct	209	441,466	48,397	57,709	5,379	1,403	1,370	-	555,724	22,504	1,582	34,146	497,492	0.81	0.90	0.997
2009	48	20-Mar	21-Oct	216	466,063	42,770	42,342	5,284	1,075	2,428	91	560,053	25,870	1,512	36,860	495,811	0.85	0.89	0.997
2010	48	18-Mar	31-Oct	228	531,107	42,257	20,073	7,689	850	2,020	2	603,998	81,968	1,452	39,210	481,368	0.89	0.80	0.998
2011	48	17-Mar	2-Nov	231	537,685	46,713	16,638	9,978	951	2,659	43	614,667	87,229	1,436	39,340	486,662	0.89	0.79	0.998
2007-2011	Average			221	495,092	45,683	38,489	7,002	1,181	1,695	27	589,170	51,665	1,520	37,415	498,570	0.85	0.85	0.997
	Minimum			209	441,466	42,257	16,638	5,284	850	-	-	555,724	22,504	1,436	34,146	481,368	0.81	0.79	0.997
	Maximum			231	537,685	48,397	57,709	9,978	1,628	2,659	91	614,667	87,229	1,617	39,340	531,518	0.89	0.90	0.998
1991-2011	Overall Average			217	503,572	50,716	28,009	6,145	1,500	404	6	590,352	60,019	1,503	36,209	492,621	0.86	0.83	0.997
	Normal Year Average			218	520,225	53,507	15,990	6,485	1,443	547	10	598,207	74,963	1,456	36,542	485,247	0.88	0.81	0.998
	Dry Year Average			215	476,511	46,180	47,539	5,592	1,594	171	-	577,587	35,735	1,579	35,670	504,603	0.84	0.87	0.997

[1] Irrigation Releases divided by the sum of Irrigation Releases, TID Drainage Pumping and TID Rented Well Pumping.

[2] Deliveries divided by Total Supply.

[3] Outflows available for beneficial use (Farm Deliveries, Irrigation Season Seepage, and Operational Spillage) divided by Total Supply.

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Table 4.9. TID Irrigated Lands Irrigation Season Water Balance Results.

		Applied Water Balance										Precipitation Balance						
		Inflows (AF)				Outflows (AF)					Closure	Inflow (AF)	Outflows (AF)					
Year	Allotment (inches)	Deliveries	Private Pumping with Surface	Treated Waste-water	Total Irrigation Supply	ET of Applied Water	Tail-water to Canals	Tail-water to Rivers	Sub-surface Drain-age to Canals	Sub-surface Drain-age to Rivers	Deep Perco-lation of Applied Water	Precipi-tation	Deep Perco-lation of Precipi-tation	ET of Precipi-tation	Uncoll-ected Runoff	Change in Storage of Precipi-tation	Net Recharge (AF/acre) [1]	Crop Consump-tive Use Fraction[2]
2007	36	531,518	16,384	5,243	553,145	385,774	1,628	-	6,680	380	158,683	37,358	646	46,335	3,736	(13,357)	0.6	0.70
2008	30	497,492	18,683	5,596	521,771	388,425	1,403	-	5,379	411	126,153	13,734	-	32,915	1,374	(20,555)	0.5	0.74
2009	48	495,811	24,509	5,233	525,553	366,411	1,075	3,318	5,284	461	149,004	45,807	32,494	40,756	413	(27,856)	0.8	0.70
2010	48	481,368	18,241	5,550	505,159	322,643	850	2,760	7,689	1,392	169,825	61,357	44,771	67,884	12	(51,311)	1.5	0.64
2011	48	486,662	17,953	4,415	509,030	315,096	951	2,589	9,978	1,722	178,694	85,816	55,356	78,662	218	(48,418)	1.5	0.62
2007-2011	Average	498,570	19,154	5,207	522,932	355,670	1,181	1,733	7,002	873	156,472	48,814	26,653	53,310	1,151	(32,299)	1.0	0.68
	Minimum	481,368	16,384	4,415	505,159	315,096	850	-	5,284	380	126,153	13,734	-	32,915	12	(51,311)	0.5	0.62
	Maximum	531,518	24,509	5,596	553,145	388,425	1,628	3,318	9,978	1,722	178,694	85,816	55,356	78,662	3,736	(13,357)	1.5	0.74
1991-2011	Overall Average	492,621	21,044	3,727	517,392	349,690	1,502	413	6,145	532	159,111	41,514	8,197	55,110	3,263	(25,056)	1.1	0.68
	Normal Year Average	485,247	20,875	3,705	509,827	335,403	1,443	667	6,485	573	165,257	50,619	12,853	61,448	3,626	(27,309)	1.3	0.66
	Dry Year Average	504,603	21,318	3,764	529,685	372,905	1,598	-	5,592	466	149,125	26,719	632	44,811	2,672	(21,396)	0.7	0.70

[1] The calculation of net recharge includes deep percolation of precipitation during the off-season. Total deep percolation of precipitation during the irrigation season and off season is presented in Table 4.5.
[2] The Crop Consumptive Use Fraction (CCUF) is calculated as ET of Applied Water divided by the Total Irrigation Supply.

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irrigation releases averaged 520,000 AF, and dry year releases averaged 477,000 AF, with an overall average of 504,000 AF. Releases are greater in normal years due to the greater availability of surface water.

Other sources of supply include TID drainage and rented well groundwater pumping, subsurface drainage and tailwater reuse directly entering the distribution system, and recycled water discharged to TID irrigated lands. As indicated in Table 4.8, TID drainage well pumping ranged from 42,000 AF to 48,000 AF between 2007 and 2011. The overall average for the five year period was 46,000 AF. The 1991-2011 normal and dry year averages were 54,000 AF and 46,000 AF, respectively, with an overall average of 51,000 AF. Drainage pumping is about the same in normal and dry years due to the use of drainage pumps to lower the water table and to provide flexible supply in the distribution system.

TID rented well pumping ranged from 17,000 AF to 58,000 AF between 2007 and 2011. The overall average for the five year period was 38,000 AF. The normal and dry year averages over the 1991 to 2011 period were 16,000 AF and 48,000 AF, respectively, with an overall average of 28,000 AF. Rented well pumping is increased in dry years because rented wells are used as an additional groundwater supply to meet increased irrigation demands and to compensate for reduced surface water availability.

For TID, the fraction of supply from surface water provides a means of evaluating variability in TID’s reliance on surface water supplies over time. The surface water supply fraction is calculated according to Equation 4-3:

$$\text{Surface Water Supply Fraction} = \text{Irrigation Releases} / (\text{Irrigation Releases} + \text{TID Drainage Pumping} + \text{TID Rented Well Pumping}) \quad [4\text{-}3]$$

The surface water supply fraction ranged from 0.81 to 0.89 between 2007 and 2011 with an average of 0.85. Over the 21-year period from 1991 to 2011, the fraction of supply from surface water averaged 0.88 and 0.84 in normal and dry years, respectively, with an overall average of 0.86. The reduction in the fraction of TID’s water supply from surface water in dry years demonstrates TID’s conjunctive management of surface water and groundwater supplies to maintain overall water supply reliability.

TID subsurface drainage water reuse ranged from 5,300 AF to 10,000 AF between 2007 and 2011. The overall average for the five year period was 7,000 AF. For the 1991 to 2011 period, subsurface drainage reuse averaged 6,500 AF in normal years and 5,600 AF in dry years, with an overall average of 6,100 AF. Subsurface drainage water reuse is about the same in normal and dry years, as the need to lower the water table in the areas with subsurface drains varies little from year to year.

TID tailwater reuse ranged from 850 AF to 1,600 AF between 2007 and 2011. The overall average for the five year period was 1,200 AF. For the 1991 to 2011 period, tailwater reuse averaged 1,400 AF in normal years and 1,600 AF in dry years, with an overall average of 1,500 AF. Tailwater reuse is about the same in normal and dry years.

TID spillage recovery from Harding Drain (Pump 152) resumed, as described previously, in the middle of 2008 and averaged 2,370 AF for the three full years of operation in 2009, 2010, and 2011. Spillage recovery through interception by the Ceres Main Canal (an internal flow path not included in the water balance) is estimated to be on the order of 15,000 AF per year. Spillage recovery is greater in dry years in order to maximize the use of available water supplies.

When comparing total deliveries to meet irrigation demand to the total water supply, a Delivery Fraction (DF) may be calculated to provide an indicator of distribution system performance. The DF is calculated on an annual (i.e., irrigation season) basis by dividing total deliveries by total irrigation supply according to Equation 4-4:

$$DF = \text{Farm Deliveries} / \text{Total Supply} \qquad [4\text{-}4]$$

For TID, the DF ranged from 0.79 to 0.90 between 2007 and 2011 with an average of 0.85. The DF over the 1991 to 2011 period averaged 0.81 and 0.87 in normal and dry years, respectively, with an overall average of 0.83.

Losses from the distribution system at the water supplier scale include seepage, spillage, and evaporation. Of the three loss types, only evaporation losses are non-recoverable as seepage recharges the underlying groundwater system and spillage is available by downstream water users. Between 2007 and 2011, seepage ranged between 34,000 and 39,000 AF with an average of 37,000 AF for the irrigation season. For the 1991 to 2011 period, seepage averaged 37,000 AF in normal years and 36,000 AF in dry years, with an overall average of 36,000 AF. The primary driver of seepage is the irrigation season length. TID continually evaluates lining condition and rehabilitation and relining is completed as necessary; however, seepage reduction to increase the available water supply for farm deliveries does result in a decrease in beneficial groundwater recharge.

Spillage losses varied from 23,000 AF to 87,000 AF between 2007 and 2011 with an average of 52,000 AF per year. Spillage losses for the 1991 to 2011 period averaged 75,000 AF and 36,000 AF in normal and dry years, respectively, with an overall average of 60,000 AF. In dry years, spillage losses are reduced through increased use of rented wells in the lower reaches of the distribution system, which enable operators to reduce spills by turning on and off pumps to manage spills and meet irrigation demands, while diverting less water from Turlock Lake and conveying it through the distribution system.

Evaporation losses are relatively small and constant over time. Variations from irrigation season to irrigation season result primarily from differences in season length and evaporative demand (i.e., weather) over time. Between 2007 and 2011, evaporation losses varied from 1,400 AF to 1,600 AF, with an average of 1,500 AF in losses per year. The 1991-2011 averages reflect a similar range.

Comparing total inflows to the TID distribution system available to meet irrigation demands (i.e., total supply) to total outflows to meet irrigation demands plus recoverable losses to seepage and spillage, a Water Management Fraction (WMF) may be calculated at the water supplier scale. This fraction is calculated on an annual basis for the irrigation season as the ratio of farm deliveries, operational spillage, and seepage to total irrigation supply according to Equation 4-5:

$$WMF = (\text{Farm Deliveries} + \text{Operational Spillage} + \text{Seepage}) / \text{Total Supply} \qquad [4\text{-}5]$$

Over the period from 2007 to 2011, the WMF was consistently 0.997 or 0.998, indicating that essentially all of TID's water supply is used to meet irrigation demands or is recoverable for beneficial use by down gradient surface water and groundwater users.

4.7.2 Farmed Lands Water Balance

Over the 2007 to 2011 period, TID farm deliveries ranged from 481,000 AF to 532,000 AF for the irrigation season. The overall average for the five year period was 499,000 AF. For the 1991 to 2011 period, farm deliveries averaged 485,000 AF for normal years and 505,000 AF for dry years with an overall average of 493,000 AF. Deliveries are greater in dry years due to the fact that less precipitation is available to support crop water demands in TID and evaporative demands tend to be greater. As a result, additional irrigation deliveries are needed to maintain crop production.

Other sources of farm irrigation supply include private groundwater pumping and recycled water delivered directly to farms. As indicated in Table 4.9, private groundwater pumping ranged from 16,000 AF to 25,000 AF between 2007 and 2011. The overall average for the five year period was 19,000 AF. Private pumping varied little between normal and dry years with the exception of the unusual year of 2009. This year was expected to be a third consecutive dry year, until late spring rains provided sufficient water supply to raise allotments to the normal year level. Thus, early season pumping prior to the late rains led to a greater than usual private pumping volume. TID's conjunctive management strategy provides a reliable district supply, so that the extra groundwater pumped by growers in dry years tends to be negligible. This is confirmed by the average normal and dry year private groundwater pumping over the 1991 to 2011 period, which was 21,000 AF for both year types.

Recycled water reuse is relatively steady over time due to steady generation of wastewater by the dischargers. Recycled wastewater applied directly to TID irrigated lands averaged 5,200 AF over the five year period of 2007 through 2011. A reduction of approximately 1,000 AF in 2011 may reflect increased reuse by the City of Turlock, resulting in less recycled water available for irrigation. Reuse of recycled water within TID has increased over time. The overall average for the 1991 to 2011 period is 3,700 AF, which has been similar in normal and dry years.

The objective of irrigation is to meet crop consumptive demand (ET of Applied Water or ET_{aw}) along with any other agronomic on-farm water needs. Comparing total applied irrigation water to ET_{aw}, a Crop Consumptive Use Fraction (CCUF) may be calculated to provide an indicator of on-farm irrigation performance. The CCUF is calculated on an annual (i.e., irrigation season) basis by dividing total ET_{aw} by total applied irrigation water according to Equation 4-6:

$$\text{CCUF} = \text{ET of Applied Water} / \text{Total Irrigation Supply} \qquad [4\text{-}6]$$

For TID, the CCUF ranged from 0.62 to 0.74 between 2007 and 2011 with an average of 0.68. For the 1991 to 2011 period, the CCUF is lower in normal years, averaging 0.66 as compared to 0.70 in dry years. The overall average for the 1991 to 2011 period is 0.68.

Losses from the farmed lands include tailwater (flowing to drains that either discharge to canals or to rivers) and deep percolation of applied water. All of the losses are recoverable, as tailwater may be used by downstream water users for irrigation or other purposes, and deep percolation of applied water recharges the underlying groundwater system. Between 2009 and 2011[9], tailwater discharged to rivers was estimated to range between 2,600 and 3,300 AF with an average of 2,900 AF for the irrigation season. For the 2007 to 2011 period, tailwater returning to the distribution system was estimated to range from 850 AF to 1,600 AF with an average of 1,200 AF for the irrigation season. For the period from 1991 to 2011, tailwater returning to the distribution system was approximately 1,500 AF per year.

Deep percolation of applied water varied from 126,000 AF to 179,000 AF between 2007 and 2011 with an average of 156,000 AF per year. Deep percolation for the 1991 to 2011 period averaged 165,000 AF in normal years compared to 149,000 AF in dry years, with an overall average of 159,000 AF. Annual fluctuations in deep percolation estimates result from differences in rainfall patterns and resulting applied water demands, as well as from uncertainty in the flow paths used to calculate the deep percolation amount. Due to the uncertainty in the estimated deep percolation of applied water, it is difficult to identify clear trends resulting from changes in hydrology or other factors over time; however, deep percolation of applied water tends to be less in dry years than normal years.

4.8 WATER SUPPLY RELIABILITY

TID requires a firm water supply to meet crop irrigation demand. The primary crop grown in TID is almonds requiring a large initial investment and a reliable water supply. The second most dominant cropping group is forage crops required as a food supply to sustain dairy herds in the District. Trees, vines and dairy related acreages (i.e. corn, oats, alfalfa, etc.) combined account for over 110,000 acres of irrigated crops within TID. This firm irrigation demand drives TID's conjunctive management strategy, which is designed to provide a relatively consistent water supply.

Reliability of water supplies is dependent upon the availability of surface water and groundwater supplies. As discussed in detail in Sections 3 and 4, TID's programs and practices assist in improving water supply reliability by conjunctively managing surface water and groundwater resources. However, the overall availability of irrigation surface water supplies relies upon numerous factors including future hydrology, water rights and instream flow requirements. Similarly, while Tuolumne River water imported by the TID provides the majority of recharge within the Turlock Basin, the groundwater is relied upon by various irrigation, domestic, industrial and municipal water users within the Basin, both within and outside TID boundaries. As a result, the reliability of groundwater resources is dependent upon continued recharge of the groundwater basin, and the ability for the various groundwater users to work cooperatively to manage the water supply. TID works with the other agencies within the Turlock Basin to facilitate that effort. Although water supply reliability is not within TID's sole discretion, TID will continue to manage the resources available to it, and adjust its programs and practices as needed to provide the most reliable water supplies for its customers today, and into the future.

In addition to supplies themselves, water supply reliability is dependent upon the ability to transport the water to where it is used for irrigation. TID owns and maintains its distribution system, up to and including the sidegate. TID regularly inspects the distribution system, with an

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[9] Tailwater to rivers was not estimated prior to 2009 due to lack of available data.

emphasis on identifying and fixing potential problems before they occur. The majority of the canal maintenance and system improvements are performed in the non-irrigation season (typically November through February) to avoid impacts to irrigation deliveries.

Distribution facilities from the canal to irrigated parcels are owned and maintained by the individual growers or groups of growers who have formed Improvement Districts. TID assists IDs in maintaining the facilities, and recovers the costs from the growers. Administering IDs in this way, enables quick responses when maintenance issues arise, and improves system reliability by reducing the downtime associated with repairs.

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5 Climate Change

5.1 INTRODUCTION

Climate change has the potential to directly impact the District's surface water supply and to indirectly impact groundwater supplies. The District is committed to adapting to climate change in a manner that protects the water resources for the maximum benefit while continuing to provide reliable irrigation water service. This section includes a discussion of the potential effects of climate change on the District and its water supply, followed by a description of the resulting potential impacts on water supply and quality and on water demand. Finally, actions currently underway or that could be implemented to help mitigate future impacts are identified.

5.2 POTENTIAL CLIMATE CHANGE EFFECTS

Several potential effects of climate change have been identified by the scientific community, including reduced winter snowpack, more variable and extreme weather conditions, shorter winters, and increased evaporative demand. Additionally, climate change could affect water quality through increased flooding and erosion; greater concentration of contaminants, if any, in the water supply; and warmer water which could lead to increased growth of algae and other aquatic plants. Rising sea level and increased flooding are also potential effects of climate change. The District is required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. In addition, the District conveys some stormwater from adjacent urban areas through its distribution system. Stormwater management, however, is the responsibility of the communities. TID's irrigation facilities merely provide a conveyance to the river system. Additionally, TID is not located within the Sacramento-San Joaquin River Delta. As a result, this discussion of climate change focuses on climate change effects and impacts related to the District's water supply and demand and does not discuss potential effects of rising sea level and increased flooding.

5.2.1 Sources of Information Describing Potential Climate Change Effects

Existing historical data and projections of future hydrology can be used to evaluate potential climate change effects. For this AWMP, historical full natural flow in the Tuolumne River at LaGrange is evaluated, along with projected changes to Tuolumne River hydrology over the next 100 years. In order to better understand potential climate change effects on the District's surface water supply, TID, in cooperation with the San Francisco Public Utilities Commission, conducted a study completed in January 2012 to estimate the sensitivity of upper Tuolumne River flow to climate change scenarios (Hydrocomp et al. 2012). The study evaluated changes in streamflow and watershed hydrologic response to potential temperature and precipitation changes for the years 2040, 2070, and 2100, as compared to the base year of 2010. Hydrologic processes were simulated using a physically-based conceptual model. The results of this study have been summarized as part of this section.

To provide additional information describing potential future changes in the hydrology of the Tuolumne River watershed, projected future flows in the Stanislaus River at New Melones Dam (north of the Tuolumne) and in the Merced River at Pohono Bridge near Yosemite National Park (south of the Tuolumne) are also presented. Projected future flows were obtained from recent projections developed using Global Climate Models (GCMs) reported by USBR (USBR 2011).

Projected future flows for the Tuolumne River are not available as part of the information reported by USBR; however projected hydrologic trends in the Stanislaus River to the north and the Merced River to the south are likely similar to those that will occur in the Tuolumne River watershed and can be compared to the results of the Hydrocomp et al. (2012) study to provide greater confidence in future climate change trends affecting surface water supply.

Finally, results of a study conducted by DWR (2006) evaluating potential effects of climate change on crop evapotranspiration are presented.

5.2.2 Summary of Potential Climate Change Effects

Changes in Timing of Runoff. Based on available historical data and projected future streamflow, the amount of annual runoff occurring during the spring-summer period from April through July has decreased over the past century and will continue to decrease in the next century.

Tuolumne River unimpaired flow (i.e., full natural flow) from 1900 to 2011 at LaGrange shows a decreasing trend in April to July runoff as a percentage of total water year runoff over the past century (Figure 5.1), demonstrating that increasingly more runoff has occurred during the fall-winter period, outside of the irrigation season.

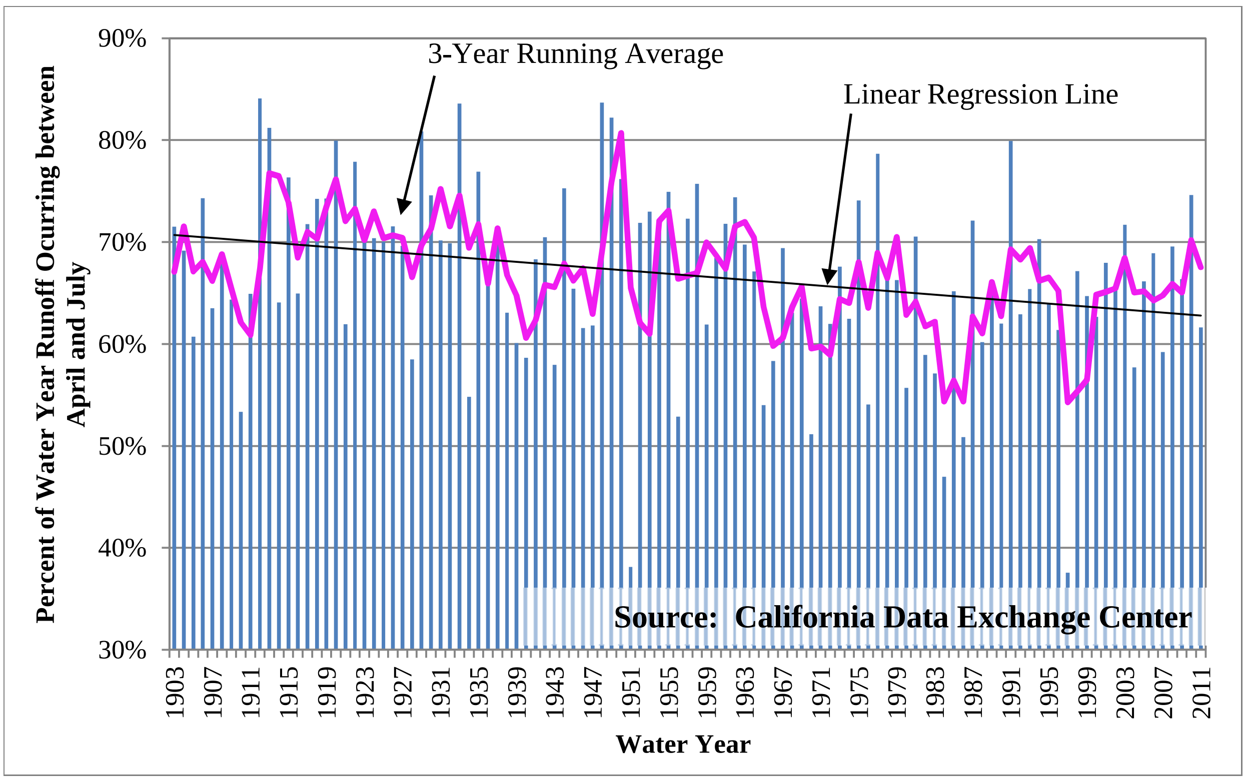

Figure 5.1. Annual April through July Unimpaired Runoff for Tuolumne River at LaGrange (Source: CDEC, 2012).

The percentage of total runoff occurring during the April-July period is expected to continue to decline over the next century, as demonstrated by the results of the study conducted by Hydrocomp (2012), which projected monthly unimpaired runoff volumes for 2040, 2070, and 2100 for two alternative climate scenarios representing moderate temperature increase with no precipitation change (Scenario 2A) and moderate temperature increase with a decrease in precipitation (Scenario 2B)[10]. The projections suggest that Tuolumne River runoff at Don Pedro Reservoir occurring during the April to July period could decrease from around 60 percent of total runoff in 2010 to only 30 to 40 percent of total runoff in 2100 (Figure 5.2). In the Figure, projected changes in April to July runoff for the Stanislaus River at New Melones Reservoir and the Merced River at Pohono Bridge (USBR 2011) are also provided for comparison. Projected trends are similar for each of the three rivers.

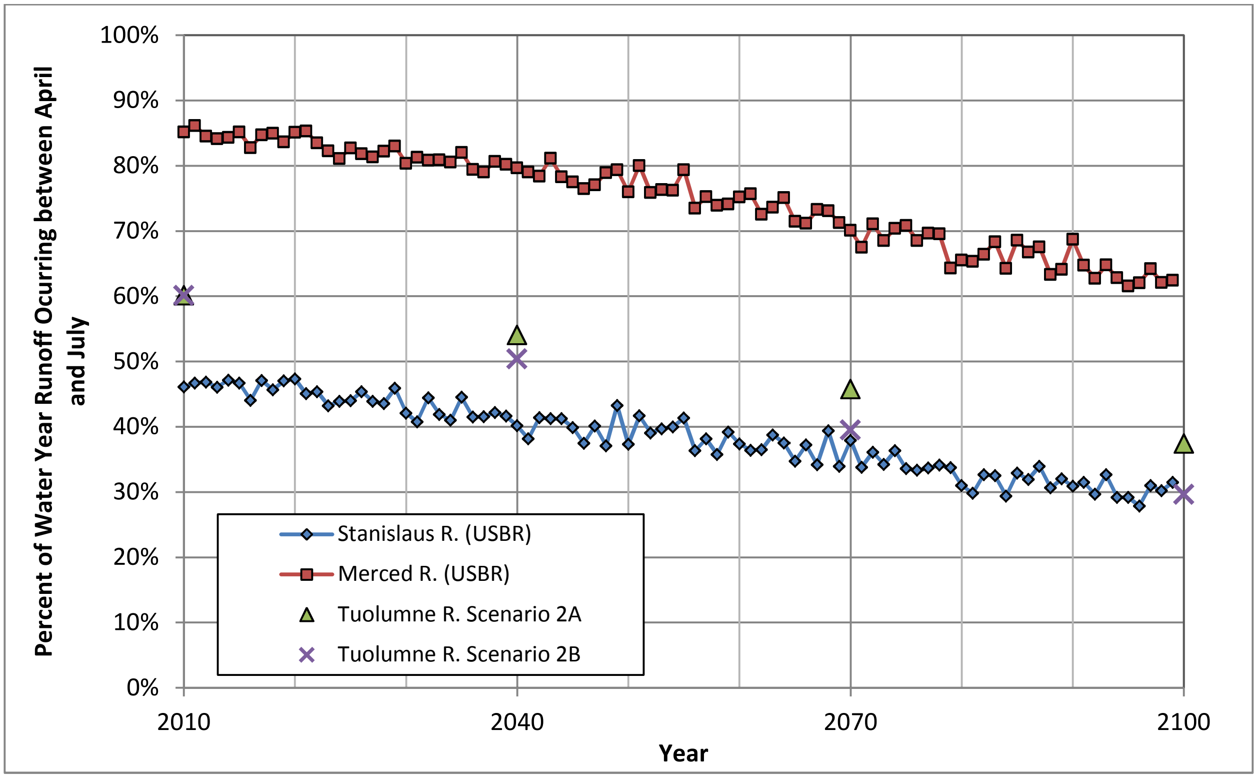

Figure 5.2. Annual April through July Unimpaired Runoff Projected for Tuolumne River Climate change Scenarios 2A and 2B (Hydrocomp et al. 2012) and Stanislaus and Merced Rivers (USBR 2011).

Changes in Total Runoff. Total water year runoff has not decreased substantially during the last century; however projections reported by Hydrocomp et al. (2012) and USBR (2011) suggest that total runoff could decrease over the next 100 years. The Hydrocomp et al. study provides estimates of Tuolumne River total annual runoff as a percentage of 2010 total runoff for 2040, 2070, and 2100 for the following six alternative climate change scenarios and corresponding changes in mean annual temperature and precipitation in the Tuolumne River watershed by 2100:

- 1A – low temperature increase (+3.6°F by 2100); no precipitation change
- 2A – moderate temperature increase (+6.1°F by 2100); no precipitation change

[10] Scenario 2A corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with no change in mean annual precipitation. Scenario 2B corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with a 15 inch decrease in mean annual precipitation in the watershed.

- 2B – moderate temperature increase (+6.1°F by 2100); precipitation decrease (-15 in by 2100)
- 2C – moderate temperature increase (+6.1°F by 2100); precipitation increase (+6 in by 2100)
- 3A – high temperature increase (+9.7°F by 2100); no precipitation change
- 3B – high temperature increase (+9.7°F by 2100); precipitation decrease (-15 in by 2100)

As shown in Figure 5.3, total runoff in the Tuolumne River at Don Pedro Reservoir could decrease to as little as 70 percent of the 2010 total by 2100, with a median projection that total runoff in 2100 will be approximately 87 percent of the 2010 total.

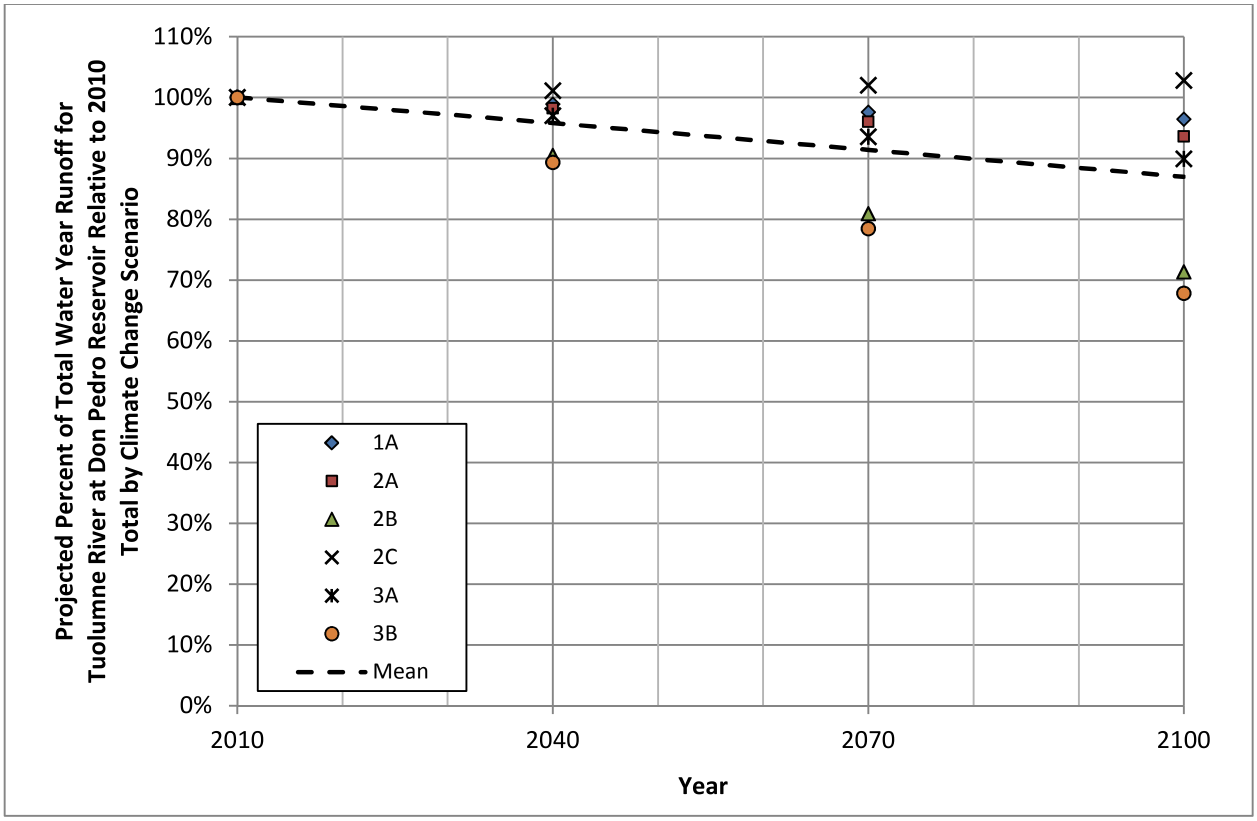

Figure 5.3. Total Projected Tuolumne River Runoff as a Percent of 2010 Runoff by Climate Change Scenario (Sources: Hydrocomp et al., 2012 and USBR 2011).

Projections of total runoff over the next century reported by USBR (2011) for the Stanislaus River to the north and in the Merced River to the south also suggest a decrease in total runoff (Figures 5.4 and 5.5). The figures show the 5th percentile, median, and 95th percentile annual runoff for 2010 to 2100 based on 112 separate hydrologic projections. The percent of total water year runoff in 2100 for the Stanislaus River and Merced River is similar to the projected decrease for the Tuolumne River.

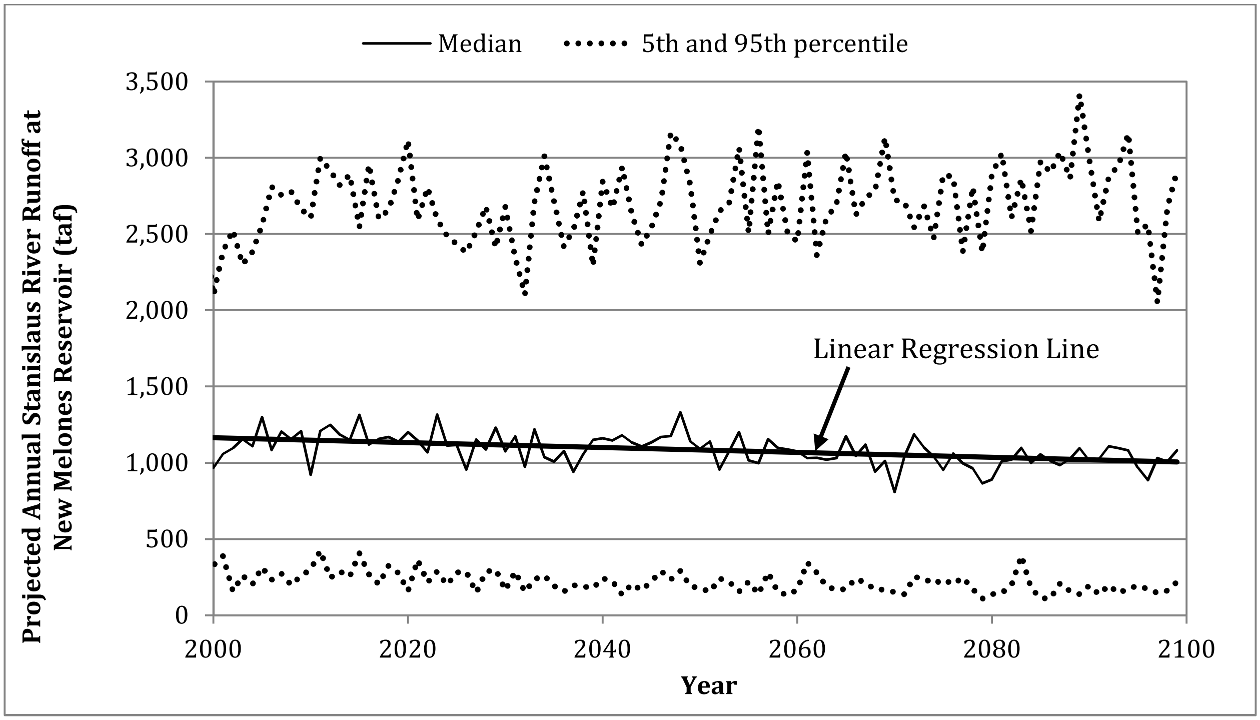

Figure 5.4. Annual Stanislaus River Runoff at New Melones Reservoir Based on 112 Hydrologic Projections (USBR 2011).

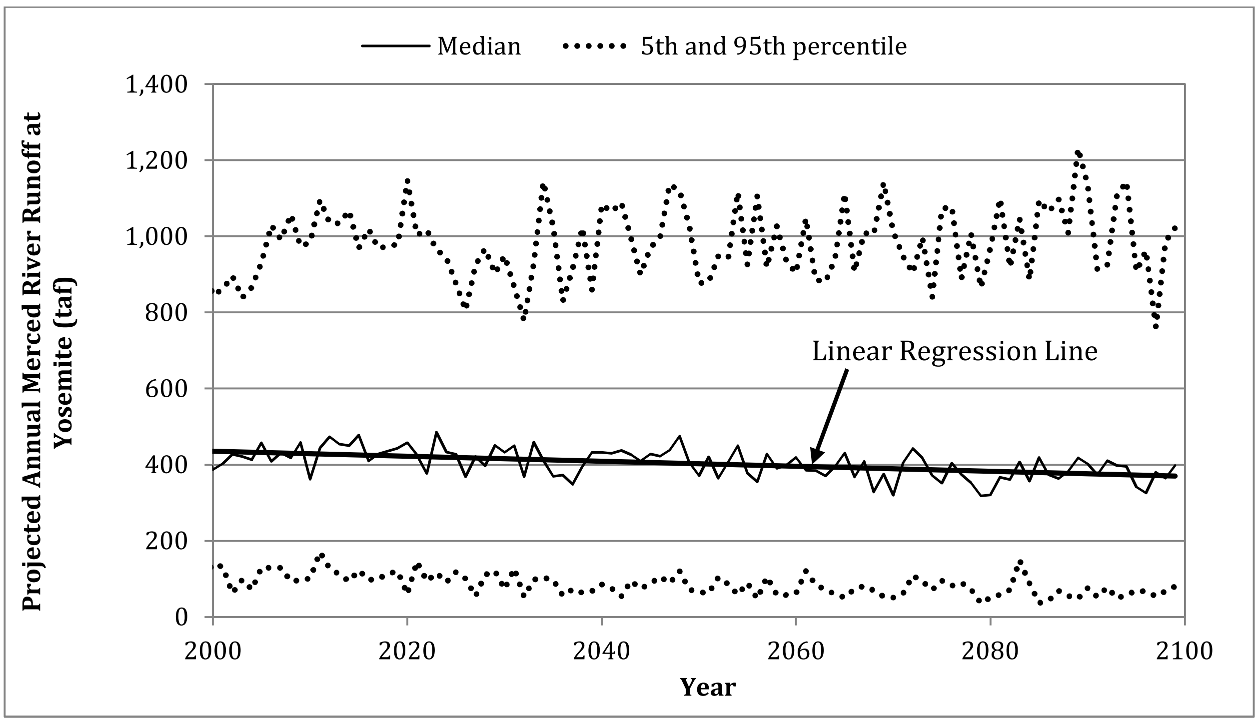

Figure 5.5. Annual Merced River Runoff at Yosemite Based on 112 Hydrologic Projections (USBR 2011).

<u>Changes in Crop Evapotranspiration.</u> In addition to the shift of runoff from the spring to the winter period, temperatures in California have increased by approximately 1°F over the last century. All else remaining equal, increased temperature will lead to increased crop evapotranspiration. These increases may be offset to some extent by reduced transpiration due to increased atmospheric carbon dioxide concentrations and changes in other factors that drive crop water demands, such as humidity, incoming solar radiation, and wind. An example of the potential increase in evaporative demand if temperature increases and other factors remain unchanged is shown in Figure 5.6. The figure was developed based on an analysis of monthly mean climate data from Davis, California assuming an increase in air temperature of 3°F, an increase in air temperature and dew point temperature of 3°F, and finally an increase in air temperature and dew point temperature coupled with an increase in canopy resistance.

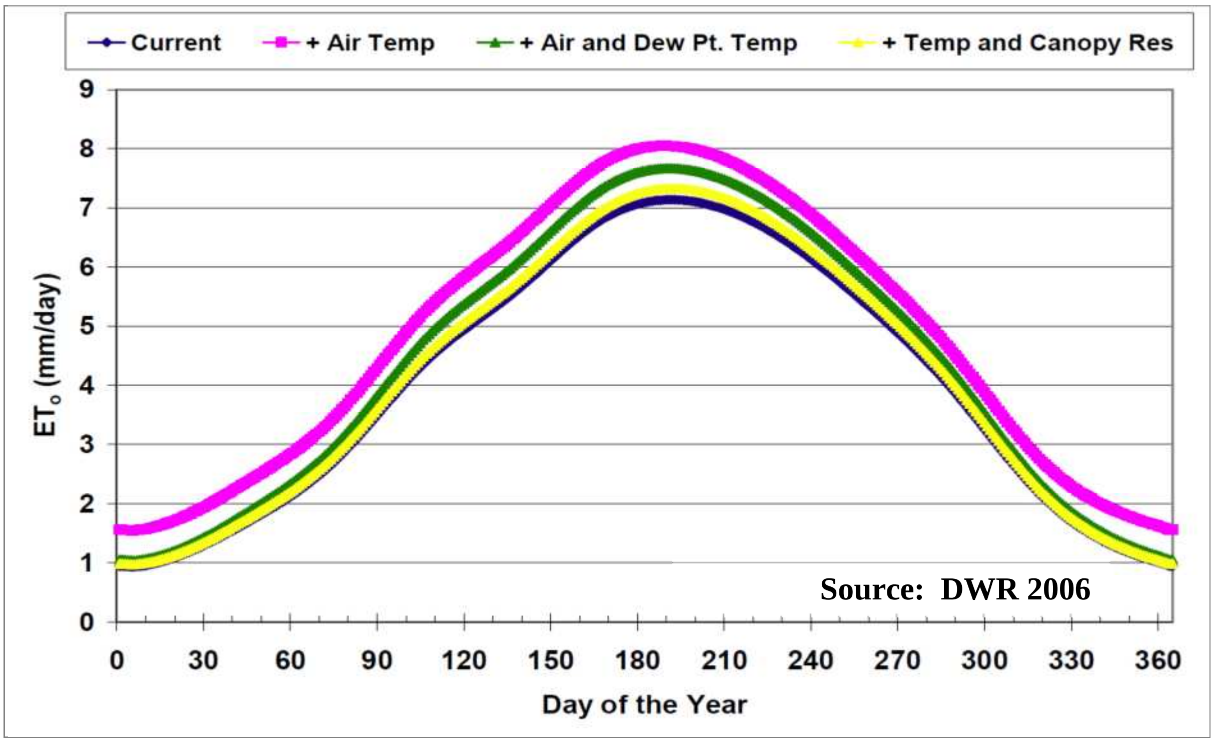

Figure 5.6. Sensitivity of Reference Evapotranspiration to Hypothetical Changes in Climate (DWR 2006).

5.3 POTENTIAL IMPACTS ON WATER SUPPLY AND QUALITY

The shift in runoff to the winter period and projected reduction in total runoff have the potential to impact surface water supply in the future if sufficient storage is not available to retain winter runoff until it is needed to meet irrigation demands and to provide additional carryover storage from wet years to dry years.

Increased erosion and turbidity under climate change, if it occurred, would likely not significantly affect the water quality of the Tuolumne River as it affects agricultural irrigation. Additionally, there are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff were to decrease, particularly due to the dilution of such contaminants in reservoirs upstream of the District. Increased water temperature could result in additional challenges in controlling aquatic plants in TID's distribution system to maintain capacity, to the extent that the increase is great enough to result in substantially increased plant growth. Increased turbidity and algae growth, if substantial, could pose challenges to filtering canal water for micro irrigation.

5.4 POTENTIAL IMPACTS ON WATER DEMAND

Increased temperature and changes to other climate factors could result in increased crop water demands, as discussed previously. Additionally, changes in precipitation timing and amounts could result in greater irrigation requirements to meet ET demands. Changes in the timing of crop planting, development, and harvest could also result in changes to the timing of irrigation demands during the year.

5.5 POTENTIAL STRATEGIES TO MITIGATE CLIMATE CHANGE IMPACTS

Although there is a growing consensus that climate change is occurring, and many scientists believe the effects of climate change are being observed, the timing and magnitude of climate change impacts remains uncertain. The District will mitigate climate change impacts with this uncertainty in mind through an adaptive management approach in cooperation with other regional stakeholders, including municipalities within the District, neighboring irrigation districts, and other interested parties. Under adaptive management, key uncertainties will be identified and monitored (e.g., April – July runoff as a percentage of annual runoff, total runoff, average temperature, and reference evapotranspiration), and strategies will be developed to address the related climate change impacts. As the impacts are observed to occur, the strategies will be prioritized, modified as needed, and implemented.

Several strategies for agricultural water providers and other water resources entities to mitigate climate change impacts have been identified (DWR 2008, CDM 2011). These strategies include those identified as part of the California Water Plan 2009 Update (DWR 2010a) as well as strategies identified as part of the California Climate Adaptation Strategy (CNRA 2009). Many of these strategies applicable to irrigation districts are already being implemented by the District in an appropriate form and level to meet local water management objectives and will continue to serve the District well as climate change impacts occur.

Resource strategies that are being implemented or could be implemented by the District to adapt to climate change are summarized in Table 5.1.

Table 5.1. District Strategies to Mitigate Climate Change Impacts.

Source	Strategy	Status
California Water Plan (DWR 2009)	Reduce water demand	The District is implementing all technically feasible and locally cost-effective EWMPs identified by SBx7-7 to achieve water use efficiency improvements in District operations and to encourage on-farm improvements. Additional actions to reduce water demand are considered on an ongoing basis as part of TID's water management activities.
	Improve operational efficiency and transfers	As described above and elsewhere in this AWMP, the District has and continues to implement improvements to increase operational efficiency.
	Increase water supply	The District has increased its available water supply through conjunctive management of available groundwater supplies and through reuse of drainage water. Additionally, irrigators within TID recycle treated municipal wastewater, reuse dairy nutrient water, and recapture drain water. In the future, the District will seek additional opportunities to increase available water supply, including increased conjunctive management through consideration of opportunities to increase groundwater recharge to increase available groundwater supply to compensate for reduced April through July runoff.
	Improve water quality	The District will continue to monitor surface water and groundwater quality as part of its active water quality monitoring program, and the coordination with monitoring programs conducted by others, including: quarterly ag suitability monitoring at Turlock Lake and spills, sampling and analysis of TID-owned and rented wells, quarterly ag suitability monitoring of subsurface drain discharges to the TID distribution system, real-time monitoring of canal and drain spill locations, analysis of water quality at various locations under the Irrigated Lands Program, and monitoring required as part of TID's use of aquatic herbicides.
	Practice resource stewardship	The District intrinsically supports the stewardship of agricultural lands within and surrounding its service area through its irrigation operations and resulting groundwater recharge. The District will participate in studies of aquatic life and habitat to better understand potential impacts of climate change.
	Improve flood management	The District is required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. In addition, its irrigation and drainage systems provide a passive system to collect and convey winter runoff. If runoff characteristics change substantially within the District in the future, modifications to the irrigation and/or drainage system to increase capacity or mitigate other impacts will be considered.
	Other strategies	Other strategies include crop idling, irrigated land retirement, and rainfed agriculture. Under severely reduced water supplies, growers could consider these strategies; however, it is anticipated that climate change impacts will be mitigated through the other strategies described.
California Climate Adaptation Strategy (CNRA 2009)	Aggressively increase water use efficiency	Described above under "Reduced water demand" and "Improve operational efficiency and transfers."
	Practice and promote integrated flood management	Described above under "Improve flood management."
	Enhance and sustain ecosystems	Described above under "Practice resource stewardship."
	Expand water storage and conjunctive management	Described above under "Increase water supply."
	Fix Delta water supply	Not applicable to the District.
	Preserve, upgrade, and increase monitoring, data analysis, and management	The amount of information and analysis available to support the District's water management is extensive and continues to increase substantially. For example, TID staff monitors the quantity and quality of water in the distribution system on a real-time basis to support operations and conjunctive management. Additionally, TID's water balance analysis is updated on an annual basis to inform near- and long-term water management decisions.
	Plan for and adapt to sea level rise	Projections indicate that sea levels could rise by 2 to 5 feet by 2100. Direct impacts on the District are not anticipated.

5.6 ADDITIONAL RESOURCES FOR WATER RESOURCES PLANNING FOR CLIMATE CHANGE

In addition to the study completed by Hydrocomp et al. (2012) to evaluate potential effects of climate change on the Tuolumne River watershed, much work has been done at State and regional levels to evaluate the effects and impacts of climate change and to develop strategies to manage available water resources effectively under climate change. The following list of resources provides additional information describing water resources planning for climate change:

- Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios. Hydrocomp, Inc.; San Francisco Public Utilities Commission; and Turlock Irrigation District. January 2012. (Hydrocomp et al. 2012)
- Progress on Incorporating Climate Change into Planning and Management of California's Water Resources. California Department of Water Resources Technical Memorandum. July 2006. (DWR 2006)
- Climate Change and Water. Intergovernmental Panel on Climate Change. June 2008. (IPC 2008)
- Managing An Uncertain Future: Climate Change Adaptation Strategies for California's Water. California Department of Water Resources Report. October 2008. (DWR 2008)
- 2009 California Climate Change Adaptation Strategy. California Natural Resources Agency Report to the Governor. December 2009. (CNRA 2009)
- Climate Change and Water Resources Management: A Federal Perspective. U.S. Geological Survey. (USGS 2009)
- Managing an Uncertain Future. California Water Plan Update 2009. Volume 1, Chapter 5. March 2010. (DWR 2010a)
- Climate Change Characterization and Analysis in California Water Resources Planning Studies. California Department of Water Resources Final Report. December 2010. (DWR 2010b)
- Climate Change Handbook for Regional Water Planning. Prepared for U.S. Environmental Protection Agency and California Department of Water Resources by CDM. November 2011. (CDM 2011)
- Climate Action Plan—Phase 1: Greenhouse Gas Emissions Reduction Plan. California Department of Water Resources. May 2012. (DWR 2012)
- Climate Change and Integrated Regional Water Management in California: A Preliminary Assessment of Regional Perspectives. Department of Environmental Science, Policy and Management. University of California at Berkeley. June 2012. (UCB 2012)

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6 Efficient Water Management Practices

6.1 INTRODUCTION

This section describes the actions that TID has taken and is planning to take to accomplish improved and more efficient water management. These actions are organized with respect to the Efficient Water Management Practices (EWMPs) described in California Water Code §10608.48. The Code lists two types of EWMPs: critical EWMPs that are mandatory for all agricultural water suppliers subject to the Code and additional EWMPs that are mandatory if found to be technically feasible and locally cost effective.

The two mandatory EWMPs are measurement of the volume of water delivered to customers with sufficient accuracy for aggregate reporting and adoption of a pricing structure based at least in part on the quantity delivered. TID is actively implementing the delivery measurement accuracy EWMP and has included a plan to comply with the agricultural water delivery measurement regulation California Code of Regulations (CCR) Title 23 §597 in Attachment F. The TID Board adopted a volumetric pricing structure in June 2012 to be implemented beginning with the 2013 irrigation season. The volumetric rate structure is described in Section 2 of this AWMP. TID has implemented and plans to continue implementing all additional (i.e., conditional) EWMPs that are technically feasible and locally cost effective. Table 6.1 describes each EWMP and summarizes TID’s implementation status.

6.2 DELIVERY MEASUREMENT ACCURACY (10608.48.B(1))

STATUS: IMPLEMENTING

The delivery point through which water is delivered from a TID lateral to a grower’s parcel or an improvement district facility is called a *Sidegate*. Sidegates are operated for measurement by setting the valve stem opening required for the standard design flow of 15 or 20 cfs given the hydraulic conditions at that sidegate. Historically, the stem opening has been set such that the end user is receiving the standard design flow for that pipeline.

The valve stem opening has been determined from flow measurements made by trained TID employees using portable electromagnetic velocity meters, which measure velocity in the irrigation pipeline or ditch, downstream of the sidegate. Flow is calculated by multiplying the measured velocity by the area. The correct stem openings (providing a standard 15 or 20 cfs head) have been provided to the Water Distribution Operators (WDOs), the field staff who deliver the water, as well as each grower. A gate stem opening and associated flow rate is assigned to each parcel in the database record used to compute water use.

TID also provides water to a limited number of non-standard deliveries, mainly parcels served by pressurized systems. Deliveries to these parcels have been assigned a modified flow based on the individual irrigation system configuration.

Growers are billed for the volume of water delivered. When a grower completes an irrigation event, they contact the WDO to give the start and stop times for the irrigation, and the WDO records the times on a water receipt. The volume delivered is calculated by multiplying the flow rate by the duration of the delivery.

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Table 6.1. Summary of Critical and Conditional EWMPs (Water Code Sections 10608.48 b & c)

Water Code Reference No.	EWMP Description	Implementation Status	AWMP Section
Critical EWMPs – Mandatory			
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	6.2
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	6.3
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible			
10608.48.c(1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	6.4.1
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	6.4.2
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	6.4.3
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	6.4.4
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	6.4.5
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	6.4.6
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	6.4.7
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	6.4.8
10608.48.c(9)	Automate canal control structures	Implementing	6.4.9

Water Code Reference No.	EWMP Description	Implementation Status	AWMP Section
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	6.4.10
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	6.4.11
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	6.4.12
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	6.4.13
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	6.4.14

Using TID sidegates to measure individual customer deliveries in this manner is complicated by a number of factors which make using this method, in some locations, potentially problematic for meeting or verifying the newly established accuracy standards contained within the newly promulgated Agricultural Water Measurement Regulation found in the California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597). Therefore, pursuant to 23 CCR §597.4(e)(4), a corrective action plan to be fully compliant with the new regulation by December 31, 2015 has been developed, and included in Appendix F.

The corrective action plan includes a two-pronged approach to delivery measurement which will enable TID to establish parcel specific flows, or directly measure the volume of water delivered to each parcel. First, TID plans to install new continuous flow measurement devices on pressurized systems and approximately 125 sidegates serving large areas and many parcels, which together account for more than half the irrigated acreage within TID. For the remaining sidegates, TID is developing standard flow measurement procedures to determine parcel specific flows at each sidegate, and standardizing the conversion from flow rate to volume delivered. Standard hydraulic conditions will ensure the parcel specific average flow rates and the corresponding volume measurements are sufficiently accurate to comply with the regulation.

6.3 VOLUMETRIC PRICING (10608.48.B(2))

STATUS: IMPLEMENTING

TID has adopted a volumetric pricing structure that will begin with the 2013 irrigation season. The Proposition 218 process was completed and the Board adopted the new pricing structure in June 2012. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included. A detailed description of the new volumetric pricing structure is included in Section 2 of this AWMP.

6.4 ADDITIONAL CONDITIONAL EWMPS

CWC §10608.48.c requires agricultural water suppliers to implement 14 additional EWMPs "if the measures are locally cost effective and technically feasible." As part of its ongoing water management activities, TID is implementing all of these measures, except one that is not technically feasible, as described in the following sections.

6.4.1 Alternative Land Use (10608.48.c(1))

STATUS: NOT TECHNICALLY FEASIBLE

Facilitating alternative land use, as envisioned through implementation of this EWMP is not technically feasible. This EWMP was designed to focus on resolving problems for lands with exceptionally high water duties or lands where irrigation contributes to significant problems. TID has neither of these conditions within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring (see Section 2.8.1).

Some areas within TID require drainage to sustain maximum agricultural production. Shallow groundwater in these areas is suitable for irrigation and is used as a source of supply by TID and individual growers. Considering these factors, drainage does not pose a significant problem within TID.

Due to the factors described above, this EWMP is not technically feasible, and is not currently being implemented. If, in the future, conditions change such that this is not the case, TID will re-evaluate the EWMP implementation.

6.4.2 Recycled Water Use (10608.48.c(2))

STATUS: IMPLEMENTING

TID is implementing this EWMP by facilitating the use of available recycled water. The District accepts recycled water from municipal and industrial users within its service area into its system provided that the dischargers have the appropriate NPDES permits, and are able to meet TID specific requirements.

The City of Turlock discharges treated municipal wastewater to the Harding Drain. Historically, TID would supplement surface water supplies in Lateral 5½ with water pumped from the Harding Drain. Due to the effluent discharges to the drain, the Regional Water Quality Control Board established regulatory restrictions and extensive reporting requirements for the reuse of any water taken from the Harding Drain, making it impractical for TID to recover spillage from the drain. Therefore, TID discontinued the practice. In 2006, the City of Turlock began putting their wastewater through a tertiary treatment process which removed the restrictions on reuse. TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. From 2009 to 2011, TID reused an average of 2,370 acre-feet per year from the Harding Drain.

For 20 years, the City of Modesto, Hilmar Cheese, and City of Turlock have provided treated wastewater to irrigated lands with the TID service area, averaging 5,200 acre-feet over the last five years as described in Section 4 of this AWMP. Additionally, TID facilitates the reuse of dairy nutrient water by Improvement Districts.

TID endeavors to use recycled wastewater where possible to meet non-irrigation needs as well. In May 2007, TID converted the water source for its cooling towers at the Walnut Energy Center in Turlock to tertiary treated wastewater effluent from the City of Turlock. Since that time, TID has used approximately 1,000 AF per year of effluent, reducing TID's non-irrigation pumping needs by an equivalent amount.

TID has been implementing and will continue to implement locally cost effective and technically feasible practices consistent with this EWMP. In the future, TID will continue to identify and evaluate opportunities for use of recycled water that conform to regulatory and agronomic water quality standards and resource requirements.

6.4.3 Capital Improvements for On-Farm Irrigation Systems (10608.48.c(3))

STATUS: IMPLEMENTING

TID is implementing the EWMP to facilitate capital improvements for on-farm irrigation systems through a variety of programs described below.

TID has an active financing program to support on-farm capital improvements of irrigation facilities through the formation of new Improvement Districts (IDs), and on-going maintenance and support of existing IDs. Improvement Districts are formed by groups of growers to build, operate and maintain on-farm water distribution systems, subsurface drain systems, deep wells, and micro irrigation systems. There are currently 1,043 IDs that deliver water from the TID canals and laterals to individual growers. IDs own approximately 700 miles of lined irrigation delivery ditches and pipelines, serving 128,400 acres within TID (92% of TID irrigated lands).

TID provides low interest financing, engineering design, and installation oversight for these facilities. In addition, TID provides at-cost maintenance and repair to ID facilities. Financial assistance is further provided to each ID on a short-term basis through TID's assessment process. Maintenance, electrical charges, and repairs for the year are carried by TID interest-free and billed to ID members in November of each year. ID members have the option of paying the assessment in two installments with no interest or penalties. For very large assessments, TID will work with an ID to establish a multiple-year assessment that distributes the costs over a longer period. Multiple-year assessments are also interest-free and typically last two to three years.

TID also seeks out grant funding to assist its growers with on-farm improvements. In 2002, TID was awarded a Proposition 13 grant to provide financial assistance to growers to install positive shutoff devices on field drains. Between 2004 and 2006 this program provided cost-sharing for the installation of 125 positive shutoff structures and removal of 152 field drains that were no longer required. In total, the grant provided direct financial assistance to growers of approximately $121,500. TID will continue to evaluate future external funding opportunities to assist growers with on-farm irrigation improvements.

TID has been implementing and will continue to implement this EWMP. In the future, TID will continue to identify and evaluate opportunities to facilitate financial assistance for on-farm capital improvements.

6.4.4 Incentive Pricing Structures (10608.48.c(4))

STATUS: IMPLEMENTING

TID is implementing this EWMP by implementing a pricing structure that promotes the following goals identified in the CWC:

1. More efficient water use at the farm level
2. Conjunctive use of groundwater
3. Increase groundwater recharge
4. Reduction in problem drainage
5. Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.

By implementing a tiered pricing structure with water rates per acre-foot delivered increasing with each tier purchased, TID promotes efficient water use at the farm level (goal 1, above) while also discouraging excessive or "problem" drainage (goal 4, above).

TID's pricing structure also promotes conjunctive use of groundwater and appropriate increases in groundwater recharge (goals 2 and 3, above) as part of the District's overall conjunctive management strategy through the following mechanisms:

- Encouraging the use of available surface water supplies and groundwater recharge by keeping surface water rates low relative to the cost of groundwater pumping,
- Encouraging conservation of limited surface water supplies in dry years by increasing the cost per acre-foot delivered, and
- Implementing the dry year rate structure, enables the District to generate additional revenue to pay for increased groundwater pumping in dry years.

TID's pricing structure promotes effective management of all water sources throughout each year by adjusting its pricing structure in dry years as compared to normal years. TID's pricing structure is described in greater detail in Section 2 of this AWMP.

TID has been implementing and will continue to implement this EWMP. In the future, TID will periodically review the volumetric pricing structure and the respective rates with respect to TID's water management objectives.

6.4.5 Lining or Piping of Distribution System and Construction of Regulating Reservoirs (10608.48.c(5))

STATUS: IMPLEMENTING

TID has implemented this EWMP through: lining or pipeline conversion of 90 percent of its conveyance and distribution system; maintaining the canal lining through its canal lining maintenance program; supporting Improvement Districts in their effort to maintain and improve ID owned water conveyance facilities; and evaluating the installation of regulating reservoirs along its distribution system.

TID's conveyance and distribution system (includes Upper Main Canal from La Grange to Turlock Lake) consists of approximately 230 miles of canals, of which 207 miles are fully or partially lined (90%). Within the irrigation service area, TID has lined or piped 204 miles of the 222 miles of conveyance and distribution facilities. In total, 204 miles (92%) of TID's distribution system below Turlock Lake are fully or partially lined, with only 18 miles of unlined canals. The remaining areas of unlined canals are primarily in upland clay soils with low seepage rates. The relatively small volume of seepage from the remaining unlined and partially lined canals provides beneficial groundwater recharge as they occur near the principal overdraft area to the east of TID.

Even though most of the conveyance and distribution system is lined and total losses from the TID distribution system are low, TID implemented a canal lining project in 2006 that continued into 2008. Reducing seepage was an incidental benefit as the main purpose of this project was to reduce maintenance requirements by preventing erosion, improving the hydraulic efficiency, and reducing aquatic weed growth. TID installed approximately 4.5 miles of full or partial canal lining between 2006 and 2008.

An effective lining maintenance program is necessary to prevent seepage losses from increasing due to cracks as the concrete lining ages. TID has an active canal lining maintenance program to maintain the effectiveness of the concrete lining. TID inspects canal lining on a regular basis and rates the lining condition by canal reach. Each year, lining condition and reach ratings are reviewed and reaches selected for resurfacing with gunite primarily based on the reach condition. Over the last five to ten years, TID has resurfaced on average more than 2 miles of canal lining each year. In recent years, TID has conducted ponding tests to quantify seepage rates in lined reaches to better understand the relationship between the subjective canal reach rating system, underlying soils and seepage. This understanding will improve the reach resurfacing selection process and ultimately result in a more effective lining maintenance program. This program helps maintain hydraulic efficiency, prevent canal failure, and reduce seepage from the lined portions of the distribution system.

A substantial portion of the 700 miles of Improvement District conveyance facilities have been replaced by pipeline systems. Aging or leaking pipelines are actively maintained and are replaced as necessary. TID provides low interest loans for these improvements.

In addition to canal lining and pipeline conversion, TID evaluated the construction of regulating reservoirs in 2007 in anticipation of updating its AWMP. Specifically, reservoirs on the Ceres Main Canal at the headings of Lower Lateral 3 and Lower Lateral 4 were evaluated. The reservoirs were evaluated as part of a phased project aimed at providing increased monitoring and control of the distribution system along with regulating storage to facilitate increased flexibility to growers and spillage reduction. Ultimately, the evaluation of the project resulted in a benefit-cost ratio of 0.23, denoting that local project benefits would provide only about one quarter of the cost required to implement the project. Relative costs and projected benefits have not changed substantially, resulting in the project remaining not locally cost-effective at the current time; however, TID will continue to consider this and other opportunities in the future.

TID has implemented this EWMP by lining and maintaining the majority of its facilities and assisting IDs in doing the same. TID will continue these efforts in the future. Additionally, TID will continue to consider the construction of regulating reservoirs to increase distribution system flexibility and reduce operational spillage.

6.4.6 Increased Flexibility to Water Users (10608.48.c(6))

STATUS: IMPLEMENTING

TID is implementing this EWMP by providing arranged demand delivery allowing for a wide range of flexibility in the frequency and duration of irrigation deliveries to its customers.

TID has been a pioneer in implementing increased flexibility for water users. TID has implemented an arranged demand ordering and delivery system where the frequency and duration of delivery are highly flexible, and the rate of flow is standardized based on capacities of distribution system and improvement district facilities. The mean time between the Call Center receiving a grower’s call and the start of the requested delivery is 50 hours, or about 2 days.

Additionally, prior to the start of the 2008 irrigation season, TID moved its Central Call Center to the Customer Service Department to provide an increased level of customer service in taking water orders. Growers can plan and manage water use on each parcel by requesting a copy of their water use records when placing a water order or at any other time of the year. At the end of each irrigation season, growers are also mailed a water use statement that details the number of irrigations, the amount of water applied during each irrigation, and total water use for the season.

Distribution system improvements and careful operation of the distribution system by TID allows growers adjacent to TID canals and laterals and on some improvement district pipelines to have non-standard heads of water for micro irrigation systems. Over time, TID continues to work to accommodate growers who have converted their fields to micro irrigation. Real time SCADA monitoring of distribution system flows, water levels, and spillage by Water Distribution Operators (WDOs) in recent years has allowed TID to improve flexibility to water users while maintaining distribution system efficiency.

TID is currently in the process of implementing online water ordering as well as the availability of online historical water use information to growers for their parcels. This will further increase the flexibility in water ordering by TID’s customers and is expected to be implemented in 2014.

TID has implemented numerous measures to increase flexibility in water ordering by, and delivery to, water users within operational limits, and will continue to implement locally cost effective improvements consistent with this EWMP in the future.

6.4.7 Supplier Spill and Tailwater Recovery Systems (10608.48.c(7))

STATUS: IMPLEMENTING

TID is implementing this EWMP through the interception of spillage from its upper laterals via the Ceres Main Canal, which can then be delivered to lower laterals to meet irrigation demands; through spillage recovery from the Harding Drain; through real time monitoring distribution system spills; and through operation of drainage wells and rented wells to provide a localized source of supply and reduce spillage.

The majority of lands in TID receiving surface water are irrigated with basin check systems that produce no tailwater. Some tailwater is generated on the heavier soils of the northeastern portion of TID. The majority of growers in this area have control structures to prevent irrigation tailwater from flowing back into the distribution system. A small quantity of tailwater generated in the irrigation service area is intercepted by agricultural drains that flow into the distribution system. This water is blended with the water in the canals and delivered as irrigation water to the greatest extent possible. A survey of lands indicates that tailwater generated on approximately 2,700 acres (less than 2% of TID lands) ultimately enters the distribution system. An additional 8,200 acres in TID can also produce tailwater, but this water does not enter the TID distribution system. Tailwater not entering the distribution system is available for recovery and reuse by growers within and outside of TID.

The Ceres Main Canal intercepts spillage from upper laterals 2 through 4 (see the District map in Appendix D). Intercepted spillage is then used as a source of supply to help meet irrigation demands in lower laterals west of the canal. In 2011, approximately 15,000 AF of spillage was intercepted by the Ceres Main Canal.

Additionally, some long improvement district pipelines were designed and constructed so they terminate at a TID canal in order to recover undelivered irrigation water where it can be used for irrigation delivery downstream. This undelivered water originates from fill up and run down water, or when growers choose to not take a delivery. The volume of water that is recovered in this manner has not been quantified independently due to its intermittent nature, but is reflected in the water balance closure to determine deliveries to farms.

As described previously in Section 6.4.2, TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. From 2009 to 2011, TID reused an average of 2,370 acre-feet per year from the Harding Drain. There are also several private, grower-operated systems that recover a mixture of drainage water and operational spills to meet irrigation demands. The extent to which this occurs is not quantified as it occurs downstream of the distribution system and outside of the water balance area.

TID has completed installation of SCADA monitoring equipment at its spillage sites. In 2007 TID began upgrading the pressure transducers originally installed with the SCADA equipment to improve calibration. The majority of SCADA flow measurement sites have recently been upgraded with float-operated sensors to improve measurement accuracy. The remaining two are scheduled to be upgraded by the end of 2013. TID has linked the SCADA monitoring equipment to WDO cell phones so that a WDO can check the real-time spillage on any lateral. This program increases WDO awareness of spillage and results in spillage reduction through more precise operation of the distribution system.

As of August of 2012, the District has 60 SCADA sites that transmit to two master radios located at electrical substations. The serial data is collected at these two sites and transmitted over a fiber optic network to TID's SCADA system. The District is currently working on a master plan to expand its SCADA capabilities. The Plan is based on three goals:

- Maintain and upgrade the SCADA system to meet current and future needs.
- Create a centralized repository for water records and increase accessibility to SCADA data.
- Expand SCADA capabilities to incorporate cost effective water operations and water delivery efficiency improvements.

TID's efforts toward these goals include the development of mobile access to data, remote operation and monitoring of irrigation control structures, and improved system redundancy. Once the master plan is complete, it is expected to provide a road map for the next 5-10 years.

The use of extensive pumping in the western portion of TID allows WDOs to tightly control the bottom end of the distribution system in response to irrigation demand. Under this operating regime, operational spills are reduced from what would otherwise occur if diversions from Turlock Lake were used exclusively to satisfy irrigation demands low in the system. This is because long travel times from Turlock Lake make it challenging to respond to changing irrigation demands in the lower parts of the system while keeping operational spills low. This operational strategy is enhanced in dry years due to the operation of additional pumps, resulting in even less spillage.

TID has implemented and continues to operate spillage recovery, including spillage prevention measures at levels that are locally cost effective. TID has also studied regulating reservoirs as an approach to spillage prevention and recovery, but found this approach not to be cost effective at this time (see Section 6.4.5). TID will continue to evaluate the cost effectiveness of spillage and tailwater reduction opportunities in the future.

6.4.8 Increase Planned Conjunctive Use (10608.48.c(8))

STATUS: IMPLEMENTING

The District is implementing increased planned conjunctive use through a combination of actions as part of the District's overall strategy for the conjunctive management of surface water and groundwater supplies. Key components of TID's conjunctive management program include the following:

- Operation of over 100 drainage wells to increase water supply and reduce spillage in the western service area;
- Rental wells to supplement available surface water supply, with an increase in the number of rented wells (up to 120 wells) in dry years;
- Pricing to promote use of available surface water supplies;
- Pricing to promote conservation of limited surface water supplies in dry years;
- Pricing to provide revenue to operate drainage and rental wells required to pump additional groundwater in dry years;
- Direct and in-lieu recharge through surplus water sales to adjacent agricultural lands east of TID's irrigation service area;
- Use of treated wastewater for cooling at the Walnut Energy Center as a substitute for groundwater;
- Active participation in local groundwater management efforts; including the Turlock Groundwater Basin Association (TGBA);
- Adoption of a revised Groundwater Management Plan in March 2008;
- Partnership with the Eastside Water District for a pilot groundwater recharge project;
- Implementation of groundwater monitoring as part of SBx7-6 (California Statewide Groundwater Elevation Monitoring or CASGEM); and
- Development of sophisticated groundwater and surface water models used as planning tools to aid conjunctive management, including a semi-automated water balance documenting surface water and groundwater use within the irrigation service area.

On average, groundwater makes up 12 percent of the TID water supply in normal water supply years. This compares to 17 percent of the TID water supply in dry years. As a result, the use and recharge of groundwater supplies are any essential part of TID's water management program.

Key components of TID's conjunctive management practices are described throughout this AWMP and have not been restated in detail within this section. TID has a long history of leadership and optimization of conjunctive management; the planned and coordinated use and monitoring of surface water and groundwater supplies to meet defined objectives. The objective of TID's conjunctive management is to provide a reliable long-term water supply to growers in both normal and dry years. TID has implemented numerous locally cost effective conjunctive management actions and will continue to evaluate and implement locally cost effective actions consistent with this EWMP in the future.

6.4.9 Automate Canal Control (10608.48.c(9))

STATUS: IMPLEMENTING

TID is implementing this EWMP by: installing, operating, and maintaining more than 330 canal control structures that automatically control canal water levels or flows based on operator targets; monitoring 60 SCADA sites in real time; and ensuring that all structure modifications allow for future automation.

TID has utilized automated canal control structures for one hundred years or more. In particular, the District's 69 "Meikle"[11] automatic gates, a type of hydraulic automatic gate believed to be unique to TID, provide water level control at lateral headings and check structures throughout the distribution system (Scobey, 1914) (Figures 6.1 and 6.2). The gates provide excellent water level control across a range of flows and require no external power.

Another "passive" structure utilized by TID to provide automatic control of canal water levels across a wide range of flows is the long crested weir. TID operates 242 long crested weirs throughout its distribution system. The simplest form of water level control, the long crested weir typically consists simply of a triangular or rectangular weir (when viewed from above) that sits within the canal channel. Because of the relatively long crest over which water flows, relatively large fluctuations in flows over the weir result in relatively small fluctuations in the canal water level upstream of the weir. This allows for steady delivery of water to irrigation gates or lateral headings upstream of the weir.

Flap gates developed by the Irrigation Training and Research Center (ITRC) at Cal Poly San Luis Obispo as a modified version of the Begemann gate are also used at 18 locations within TID's distribution system. The flap gate provides automated water level control, serving the same function as a Meikle gate or a long crested weir, but can be built and installed generally at a lesser cost. A disadvantage is that the flap gate requires a relatively large drop in water level across the control structure, limiting their applicability at many sites.

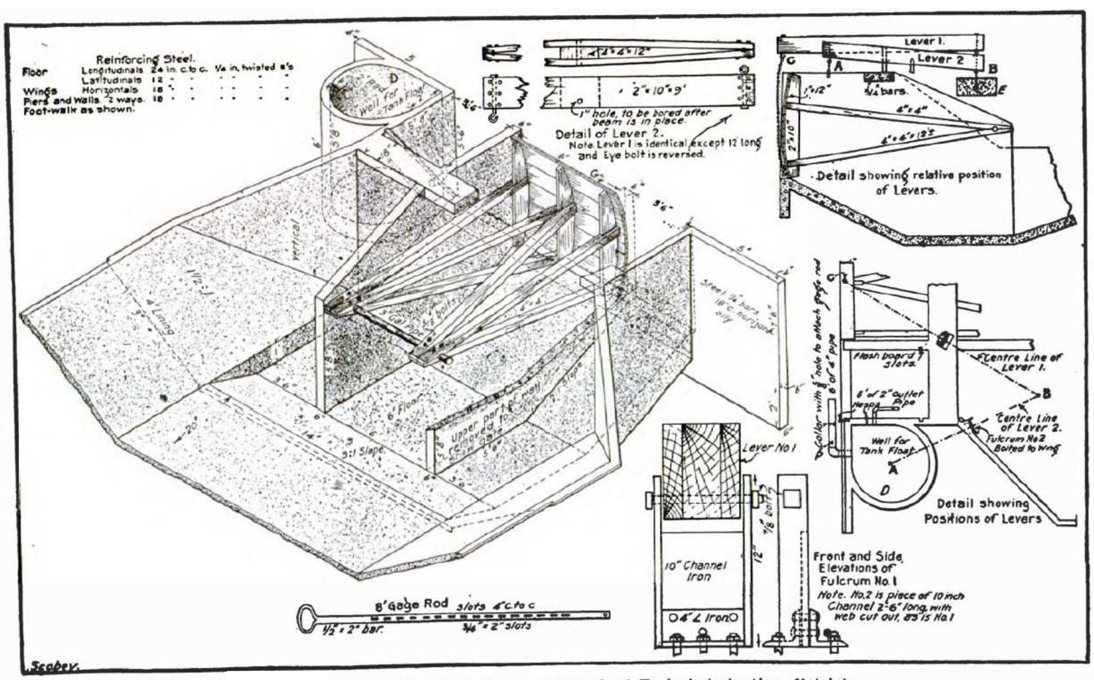
In addition to the automatic control structures described above, TID operates two Rubicon FlumeGates™. One gate is operated for automatic water level control, and the other is operated for flow control. Two Rubicon SlipMeters™ have also been installed to provide automated flow control and improved measurement accuracy for irrigation deliveries.

In addition to the various automated structures used to operate the distribution system, TID has modernized its operations through the installation of 60 sites for real time water level and flow monitoring to support optimal operation of the system by WDOs. By providing real time information to the WDOs, more precise, timely decisions can be made to perform adjustments to gates and control structures, as needed. As described in Section 6.4.7, TID plans to upgrade and expand its SCADA and automation opportunities in the future and is currently developing a SCADA master plan.

[11] Named for Mr. Roy V. Meikle, who served the Turlock Irrigation District as chief engineer for over 50 years, beginning in 1912.

-AUTOMATIC CHECK GATE, TURLOCK IRRIGATION DISTRICT, CALIFORNIA.

Figure 6.1. Photo of Meikle Automatic Gate (Source: Scobey, 1914).



—Automatic check drop on lateral of Turlock irrigation district.

Figure 6.2. Schematic of Meikle Automatic Gate (Source: Scobey, 1914).

TID implements an ongoing maintenance program, designed to ensure these automatic structures continue to operate effectively throughout the irrigation season. Canal inspections and coordination with WDOs and other field crews identify maintenance issues and expedite speedy repairs to ensure the facilities continue to operate as designed, to provide the on-going, reliable water level control and operation.

TID has implemented and continues to operate the distribution system using automatic control of water levels and flows and real time monitoring by WDOs. TID has also studied regulating reservoirs and other modernization improvements to improve distribution system operation to improve flexibility while maintaining distribution system efficiency, but found this approach not to be cost effective at this time (see Section 6.4.5). TID will continue to evaluate the cost effectiveness of canal automation and other modernization opportunities in the future.

6.4.10 Facilitate Customer Pump Testing (10608.48.c(10))

STATUS: IMPLEMENTING

TID is implementing this EWMP by conducting a pump testing program that includes providing testing services for private pumps throughout its irrigation and electrical service areas.

As part of the pump testing program, TID trained employees in pump testing methods during the 2007 irrigation season. Improvement district and other private pumps are generally tested once per year when they are rented by TID or upon request by the owner. The electrical service area includes approximately 40,000 additional cropped acres east of the irrigation service area that are irrigated almost exclusively with groundwater. Pump testing for this area is available through TID's electric department.

TID will continue to implement this program in the future and continue to evaluate locally cost-effective opportunities to expand the program as part of the district's overall management of water and electrical resources.

6.4.11 Designate Water Conservation Coordinator (10608.48.c(11))

STATUS: IMPLEMENTING

TID is implementing this EWMP by continuing to have a designated Water Conservation Coordinator (to develop and implement the AWMP and encourage continued evaluation of efficient water management practices). This position was established in June 1997 and is currently filled by the District's Water Planning Department Manager.

6.4.12 Provide for Availability of Water Management Services (10608.48.c(12))

STATUS: IMPLEMENTING

TID is implementing this EWMP through a variety of actions. These actions are summarized in the following table (Table 6.2).

The link to CIMIS on the District's website is shown in Figure 6.3. The District also provides links to additional weather information including precipitation forecasts on a Weather page on the TID web site (Figure 6.4). Real time flows and storage for six surface water sites provided on TID website, as shown in Figure 6.5. A sample of the front page of "The Grower," TID's irrigation newsletter, is shown in Figure 6.6.

Table 6.2. Summary of Water Management Services Provided to Irrigation Customers.

Water Management Service Category	TID Activities
On-farm irrigation and drainage system evaluations	Engineering design services for ID facilities
	Private and Improvement District pump testing upon request
Normal year and real-time irrigation scheduling and crop evapotranspiration information	Installation of CIMIS stations 168 (inactive) and 206 in Denair
	Rental of land and ongoing maintenance and support of Denair CIMIS station
	Link on TID web site to weather data from DWR CIMIS program (Figure 6.3) and weather forecasts (Figure 6.4)
Surface water, groundwater, and drainage water quantity and quality data	Private and Improvement District pump testing upon request
	Water use information by parcel available from TID at any time, upon grower's request, plus all growers receive a year-end water use report
	Information describing suitability of surface water, groundwater, and drain water quality for irrigation upon request
	Real time flows and storage for 6 surface water sites provided on TID website (Figure 6.5)
	TID participates in DWR's CASGEM groundwater level reporting program
Agricultural water management educational programs and materials for farmers, staff, and the public	Grower newsletter distributed three to four times per year
	Annual grower meetings
	Occasional seminars for growers on various water management topics

Figure 6.3. Link to CIMIS on TID Website.

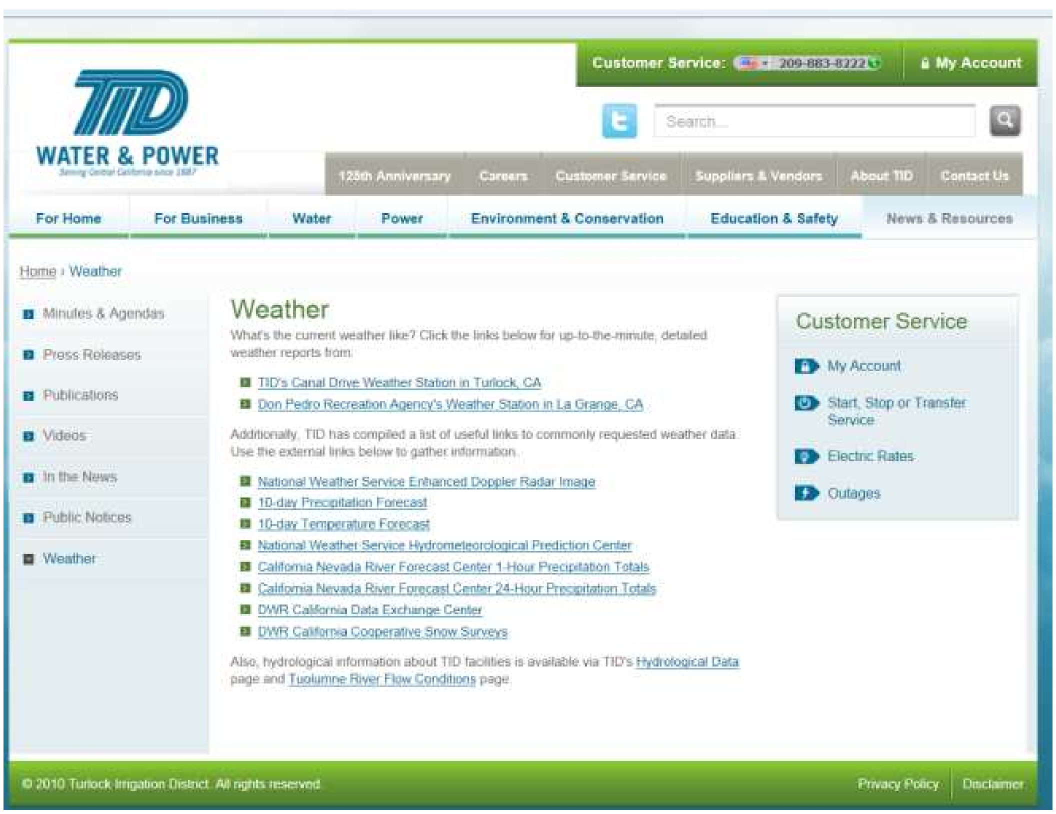


Figure 6.4. Additional Weather Information on TID Website.

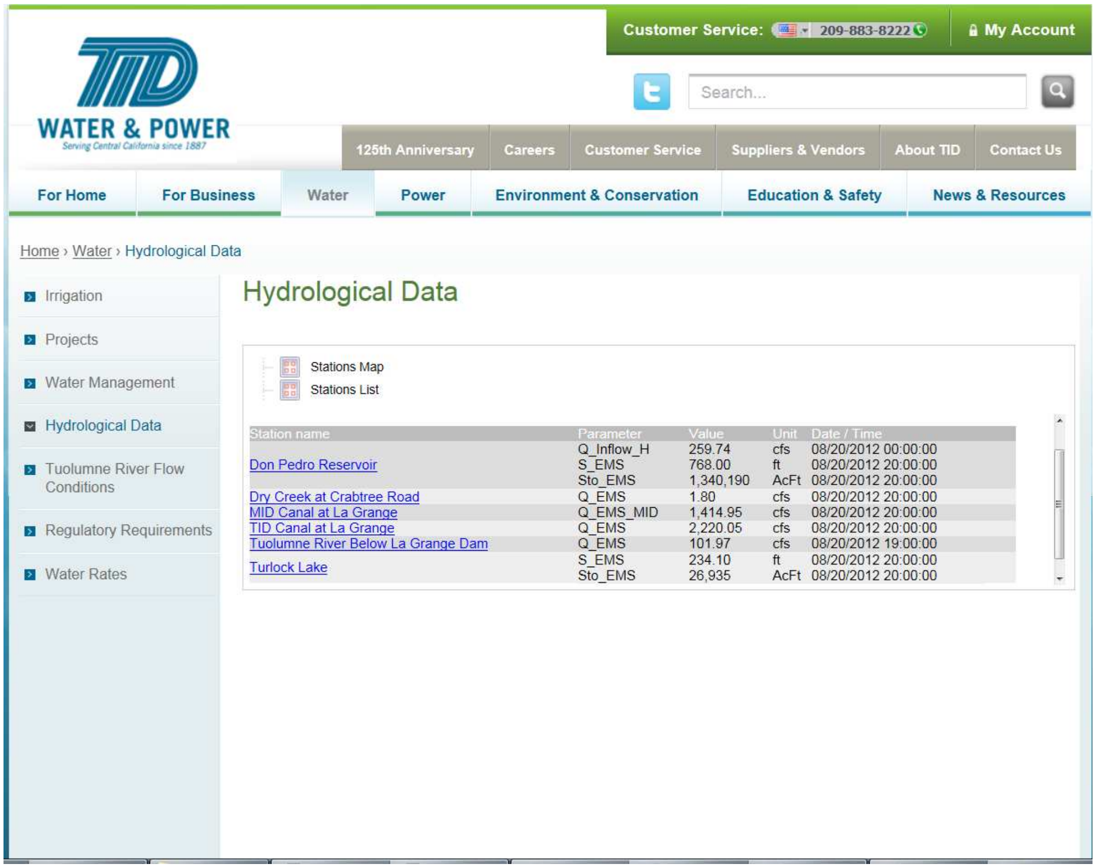


Figure 6.5. Real Time Hydrological Data on TID Website.

A Publication for Turlock Irrigation District Water Users

the Grower

Vol. 24 • No. 2 | August 2012

TID updating Ag Water Management Plan

Turlock Irrigation District is in the process of updating its Agricultural Water Management Plan (AWMP), which evaluates water use within the District and applicable management practices to make the best use of available resources.

TID's existing plan was developed under a voluntary process established in the 1990s. Legislation, passed in 2009, commonly referred to as SBx7-7 made the once voluntary program mandatory. Under the new requirements, TID must adopt a revised plan by the end of this year, update it in 2015, and then every five years thereafter.

The AWMP will describe TID's water supplies and irrigation demand, local conditions, facilities and operations, rules and policies, and a variety of water management activities, including a series of efficient water management practices (EWMPs) designed to improve water use efficiency. The AWMP documents how TID is complying with the new law, and proposes improvements, if needed, to meet new requirements.

Volumetric pricing and water measurement are two examples of EWMPs. TID adopted a new volumetric pricing structure, effective in 2013, to comply with SBx7-7 on June 12. The AWMP will describe the new pricing structure, as well as the District's plans for complying with increased water measurement accuracy and reporting, required by SBx7-7.

Another goal of SBx7-7 is to make water management data and information more readily available. AWMPs are now required to be posted on the Internet, and submitted to various local and state agencies, including the Department of Water Resources (DWR), and local urban water suppliers. DWR will report to the legislature in 2013 regarding the status of ag water management practice implementation statewide, and make recommendations on suggested improvements.

The current schedule has a draft plan for the TID Board's consideration at the end of November. Although time consuming and costly to implement, completing these planning processes, implementing efficient water management practices, and documenting their effectiveness are important steps for protecting the District's water supplies.

More information on the AWMP and EWMPs, including water measurement and pricing, will be provided in the coming months and years through *The Grower* newsletter articles like this one, and online at **www.tid.com/AWMP**.

For questions about the TID plan, or EWMPs, contact Debbie Liebersbach at (209) 883-8428.

October 10
Final day of irrigation season

Throughout November
Water Use Statements mailed

December 20
Water transfers must be completed

Interested in receiving The Grower newsletter **via email rather than a printed copy?** Please contact us via email at info@tid.org or by calling 209.883.8448.

INSIDE

- Irrigation rate structure to change in 2013
- Irrigated Lands Regulatory Program
- Drip and micro installation info

TURLOCK IRRIGATION DISTRICT 125 YEARS

Figure 6.6. Front Page of August 2012 Issue of "The Grower."

6.4.13 Evaluate Supplier Policies to Allow More Flexible Deliveries and Storage (10608.48.c(13))

STATUS: IMPLEMENTING

TID is implementing this EWMP through ongoing cooperation with Modesto Irrigation District, which co-owns Don Pedro Reservoir and by working with agencies that affect the flexibility with which TID can store and deliver water including the Federal Energy Regulatory Commission (FERC) and the Army Corps of Engineers.

TID coordinates with other agencies and entities in a variety of ways. For example, TID coordinates water releases in the Tuolumne River for fishery and other purposes with the Modesto Irrigation District and the City & County of San Francisco. TID is also coordinating with the communities of Hughson, Ceres, Turlock, and the portion of Modesto south of the Tuolumne River to evaluate the feasibility of using surface water from the Tuolumne River in conjunction with existing groundwater supplies to satisfy municipal and industrial water demand.

Another example of coordination is TID's membership in the Turlock Groundwater Basin Association (TGBA), an association of local municipal water systems, agricultural water districts, and counties. The TGBA provides a mechanism to implement groundwater management activities and provide guidance for the management, preservation, protection and enhancement of the Turlock Groundwater Basin. To this end the TGBA developed a basin wide groundwater management plan and is working to develop a basin wide monitoring plan. TID coordinates groundwater management related activities with other agencies through this forum.

TID will continue to evaluate opportunities for more flexible deliveries and storage in the future and will pursue those opportunities found to be locally cost effective.

6.4.14 Evaluate and Improve Efficiencies of Supplier's Pumps (10608.48.c(14))

STATUS: IMPLEMENTING

TID is implementing this EWMP by actively testing and monitoring TID-owned and private wells that the District rents.

In order to develop in-house pump testing capabilities, TID trained employees in pump testing methods during the 2007 irrigation season. Pumps owned by TID are tested as needed to evaluate operational changes, and reliably calculate flows. The test results are used by staff to evaluate repair and replacement options. TID has an ongoing pump capital improvement program designed to maintain the efficiency of TID owned pumps through rehabilitation or replacement when necessary.

Improvement district or other private wells that are rented by TID are tested annually. The information is utilized by TID to evaluate which pumps to rent, to accurately calculate the amount of water pumped, and the information is provided to the owner to assist with maintenance decisions.

TID will continue to implement this program in the future and continue evaluate locally cost-effective opportunities to expand the program as part of the district's overall management of water and electrical resources.

6.5 SUMMARY OF EWMP IMPLEMENTATION STATUS

TID has taken many actions throughout its 125-year history to promote efficient and sustainable water management and continues to review and plan additional measures to accomplish improved and more efficient water management. Conjunctive management of local surface water and groundwater resources is foundational to TID's overall water management strategy. For purposes of this AWMP, TID actions have been organized and are reported with respect to the Efficient Water Management Practices (EWMPs) listed in Water Code §10608.48. A summary of the implementation status of each listed EWMP is provided in Table 6.3.

TID and its staff has long been active in, and affiliated with organizations supporting excellence in water management, including the Association of California Water Agencies (ACWA), the United States Committee for Irrigation and Drainage (USCID), the Irrigation Technology and Research Center (ITRC), the American Society of Civil Engineers (ASCE), the California Irrigation Institute, the California Municipal Utilities Association (CMUA) and others. One of the benefits that TID's active participation in these organizations brings is continuing exposure to water management innovations through conferences, trainings and networking with water management professionals. Additionally TID occasionally sends staff to water management trainings to enhance skill sets and increase basic understanding of efficient water management.

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Table 6.3. Summary of TID Implementation Status for EWMPs Listed Under CWC10608.48(b) & (c).

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical EWMPs – Mandatory				
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	Developed a water measurement corrective action plan (Appendix F) pursuant to 23 CCR §597.4(e) (4).	Implement corrective action plan (Appendix F) per budget and schedule.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	Completed the Proposition 218 process and adopted a new pricing structure based in part on quantity delivered in June 2012. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included.	Begin volumetric charges through application of the new pricing structure with the 2013 irrigation season.
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible				
10608.48.c(1)	Facilitate alternative land use for lands with exception-ally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring.	
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	1. M&I wastewater in Harding Drain recycled by TID for irrigation. 2. M&I wastewater used for cooling at TID's Walnut Energy Center. 3. M&I wastewater applied directly to TID irrigated lands. 4. Dairy nutrient water used by TID improvement districts for irrigation.	1. Continue existing use of recycled water within TID. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water.
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	1. Financing of on-farm improvement district irrigation facilities. 2. Engineering design and construction oversight for on-farm improvement district irrigation facilities. 3. At-cost maintenance and repair of on-farm improvement district irrigation facilities. 4. Interest-free deferral of maintenance, repair, and electrical charges. 5. Pursuit of grant funding for on-farm improvements.	1. Continue various financing activities to support development, operation, maintenance, and repair of on-farm irrigation systems.
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	1. Pricing structure promotes more efficient water use at the farm level, conjunctive use of groundwater, appropriate increase of groundwater recharge, prevention of problem drainage, and effective management of all water sources throughout the year.	1. Continue to implement tiered pricing structure to promote TID's water management goals.
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	1. Lined or converted to pipelines over 90 percent of its distribution system. 2. Lined an additional 4.5 miles of canals between 2006 and 2008. 3. Resurfaces more than 2 miles of lining each year. 4. Improvement district pipelines are actively maintained and replaced as necessary. 5. Evaluated regulating reservoirs (not locally cost-effective at this time).	1. Continue to resurface lining each year to maintain effectiveness. 2. Install new lining as appropriate based on local cost-effectiveness. 3. Continue active maintenance and repair of improvement district pipelines. 4. Continue to evaluate regulating reservoir opportunities

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Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	1. Implemented arranged demand delivery, providing a wide range of flexibility in irrigation frequency and duration, providing water with a lead time of approximately 2 days. 2. Moved its call center in 2008 to improve customer service. 3. Provides water use information to irrigators for their fields upon request and in an annual report. 4. Worked over time to accommodate changes in demand characteristics for micro irrigation systems. 5. Operators monitor the distribution system at 60 SCADA sites to enhance operational flexibility.	1. Continue to provide high levels of delivery flexibility and evaluate locally cost effective flexibility improvements. 2. Implement online delivery ordering and online availability of historical water use.
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	1. Intercepts spillage from upper laterals in the Ceres Main Canal. 2. Recovers operational spillage from Harding Drain. 3. Recovers and reuses tailwater re-entering the distribution system. 4. Implemented real time SCADA monitoring of spill sites. 5. Operates drainage wells throughout the system, providing added operational flexibility and localized supply that enables spillage prevention.	1. Continue various strategies and actions to recover and prevent spillage and tailwater. 2. Continue to evaluate and implement locally cost effective improvements to recover and prevent spillage and tailwater.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	1. Implemented a comprehensive conjunctive management program. 2. Operates over 100 drainage wells to increase water supply. 3. Rents up to 120 wells to supplement the available surface water supply. 4. Pricing structure promotes the following conjunctive management goals: (1) encourages use of available surface water supplies, (2) encourages conservation of limited surface water supplies in dry years, and (3) provides revenue required to operate drainage wells and rental wells in dry years. 5. Promotes direct and in-lieu recharge through surplus water sales outside of the service area. 6. Substitution of M&I wastewater for groundwater to provide cooling at Walnut Energy Center. 7. Adopted GWMP, and actively participates in local groundwater management activities. 8. Implementation of groundwater monitoring as part of CASGEM. 9. Development of sophisticated water models to support long term planning and management.	1. Continue various ongoing conjunctive management strategies and actions as part of TID's comprehensive conjunctive management program. 2. Continue to evaluate and implement locally cost effective actions.
10608.48.c(9)	Automate canal control structures	Implementing	1. Operates more than 330 automatic canal control structures. 2. Monitors 60 SCADA sites providing real time flow and water level information.	1. Continue to operate and maintain automatic control structures. 2. Continue real time SCADA monitoring. 3. Continue to evaluate and implement locally cost effective actions.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	1. Provides testing of private pumps upon request within its irrigation and electrical service areas. 2. Tests all rented private wells once per year. 3. Trained employees in pump efficiency testing.	1. Continue to provide testing of private pumps and to maintain in-house pump testing capability.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	1. Designated a Water Conservation Coordinator in June 1997.	1. Continue to employ a designated Water Conservation Coordinator.

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Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	1. Provides engineering design services for improvement district facilities. 2. Provides private pump testing upon request. 3. Installed, rents land for, and maintains the Denair CIMIS site and provides a link to CIMIS on its web site. 4. Provides detailed water use information for individual fields to irrigators upon request, including a year-end water use report that is mailed to all irrigators. 5. Provides detailed information on the suitability of surface, ground, and drain water quality for irrigation upon request. 6. Provides real time hydrologic information on its website. 7. Distributes a grower newsletter multiple times per year, holds annual grower meetings, and organizes occasional seminars on various water management topics.	1. Continue to provide various water management services. 2. Continue to evaluate and implement locally cost effective services.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	1. Cooperates with the Modesto Irrigation District (MID), who co-owns Don Pedro Reservoir. 2. Coordinates with other agencies that have the potential to impact the District’s flexibility in delivery and storage. 3. Is a member of the Turlock Basin Groundwater Association (TGBA).	1. Continue cooperation with MID and others to allow more flexible deliveries and storage. 2. Continue to evaluate and implement locally cost effective opportunities.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier’s pumps.	Implementing	1. Tests District owned and rented wells. 2. Trained employees in pump efficiency testing. 3. Established an ongoing capital improvement program to rehabilitate and replace pumps as necessary.	1. Continue to test TID pumps and to maintain in-house pump testing capability. 2. Continue ongoing rehabilitation and replacement of TID pumps as necessary.

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6.6 EVALUATION OF WATER USE EFFICIENCY IMPROVEMENTS

CWC §10608.48(d) requires that AWMPs include:

> *… a report on which efficient water management practices have been implemented and are planned to be implemented, an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future.*

A description of which EWMPs have been implemented has been provided previously in Section 6. This section provides an evaluation of EWMP implementation and an estimate of water use efficiency (WUE) improvements that have occurred in the past and are expected to occur in the future.

As described elsewhere in this document, TID has, over time, effectively implemented a variety of EWMPs designed to: develop and maintain reliable surface water and groundwater supplies; prevent or reduce system losses; promote the efficient use of water; seek alternative sources of supply; and maximize the flexibility with which the District can deliver and store water. The value of evaluating WUE improvements (and EWMP implementation in general), from TID's perspective, is to identify what the benefits of EWMP implementation are and to identify those additional actions that hold the potential to improve TID's ability to provide customers with a reliable water supply.

First and foremost among the issues that must be considered in any evaluation of the benefits of EWMP implementation and WUE improvements is how any proposed actions may impact the water balance, and overall water supply availability (Davenport and Hagan, 1982; Keller, et al., 1996; Burt, et al., 2008; Clemmens, et al., 2008; Canessa, et al., 2011). For example, flows to deep percolation and seepage that could be considered losses in some settings are critical to maintain the long-term sustainability of the underlying groundwater basin. Reduced seepage or on-farm WUE improvements could be considered beneficial in some areas, but would adversely impact local groundwater recharge. Similarly, spillage and tailwater are also recoverable flows. These flows are already being recovered locally, or have the potential to be put to beneficial used downstream. The only distribution system or on-farm losses that are not recoverable within TID, the underlying groundwater basin, or the San Joaquin River Basin as a whole are canal and reservoir water surface evaporation and evaporation from irrigation application. These components represent a small portion of TID's water supply (less than one percent as indicated in Table 4.8). An implication of this is that very little water can be made available through water conservation in TID to increase the State's overall water supply.

An essential first step in evaluating EWMP implementation and WUE improvements is a comprehensive, quantitative, multi-year water balance (see Section 4). The quantitative understanding of the water balance flow paths enables identification of targeted flow paths for TID water management objectives and WUE improvements, along with improved understanding of the beneficial impacts and consequential effects of EWMP implementation at varying spatial and temporal scales. The water balance enables evaluation of potential changes in flow path quantities and timing for any given change in water management.

Even where comprehensive, multi-year water balances have been developed, evaluating water balance impacts and WUE improvements is not a trivial task. Issues of spatial and temporal scale and the relatively small changes in annual flow path volumes (relative to year to year variation in water diversions and use) that result from most water management improvements coupled with the inaccuracies inherent in even the best water measurement greatly complicate the evaluation of WUE improvements. Additionally, the implications of recoverable and irrecoverable losses at varying scales complicate the evaluation of WUE improvements, and consequential, potentially unintended consequences must be considered (Burns et al. 2000, AWMC 2004).

Given the aforementioned complexities inherent in evaluating WUE improvements and the extremely limited potential for increase to the State's overall water supply, TID has developed a qualitative assessment of past WUE improvements and those expected to occur five and ten years in the future. The qualitative magnitude is expressed as None, Limited, Modest, or Substantial in order of increasing relative magnitude for each EWMP. Past WUE improvements are estimated relative to no historical implementation and relative to the time of the last plan (adopted in 1999 and approved by the AWMC in 2001). Future WUE improvements are estimated for five years in the future (2017) relative to 2012 and for ten years in the future (2022) relative to 2012. The result of this evaluation is provided in Table 6.4.

TID will continue to seek out and implement water management actions that meet its overall water management objectives and result in WUE improvements. TID staff regularly attend water management conferences and evaluate technological advances in the context of TID's water management objectives and regional setting. The continuing review of water management within TID, coupled with exploration of innovative opportunities to improve water management will continue to result in future water management innovations and additional WUE improvements.

Table 6.4. Evaluation of Relative Magnitude of Past and Future WUE Improvements by EWMP.

Water Code Reference No.	EWMP	Implementation Status	Marginal WUE Improvements[1,2]			
			Past		Future	
			Relative to No Historical Implementation[3]	Since Last AWMP[4]	5 Years in Future[5]	10 Years in Future[5]
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy	Being Implemented	No Direct WUE Improvements			
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Being Implemented	None	None	Limited	
10608.48.c (1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Not Applicable to TID			
10608.48.c (2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils.	Being Implemented	Modest (approx. 5,000 af annually)	None	None to Limited, Depending on Future Opportunities	
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Being Implemented	Substantial	Modest	None to Modest, Depending on Future Needs	
10608.48.c (4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented	Substantial	None	Limited	
10608.48.c (5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Being Implemented	Substantial (Limited Reduction in Irrecoverable Losses)	Limited	None to Limited	
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Being Implemented	Substantial	Limited	Limited	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Being Implemented	Substantial	Limited	Limited	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Being Implemented	Substantial	None	None to Limited	
10608.48.c (9)	Automate canal control structures	Being Implemented	Substantial	Limited	Limited	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Being Implemented	Modest	None (Limited Energy Conservation)	None (Limited Energy Conservation)	
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	The activities of the Water Conservation Coordinator and other TID staff to achieve WUE improvements through implementation of the EWMPs are described individually by EWMP.			
10608.48.c (12)	Provide for the availability of water management services to water users.	Being Implemented	Substantial	Limited	None to Limited	
10608.48.c (13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Being Implemented	Substantial	None	None	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Being Implemented	Substantial	None (Limited Energy Conservation)	None (Limited Energy Conservation)	

[1] As noted herein and throughout this analysis, reductions in losses that result in WUE improvements at the farm or district scale do not result in WUE improvements at the basin scale, except in the case of evaporation reduction. All losses to seepage, spillage, tailwater, and deep percolation are recoverable within TID or by downgradient water users within the basin.

[2] In most cases, quantitative estimates of improvements are not available. Rather, qualitative estimates are provided as follows, in increasing relative magnitude: None, Limited, Modest, and Substantial.

[3] WUE Improvements occurring in recent years relative to if they were not being implemented.

[4] WUE Improvements occurring in recent years relative to the level of implementation at time of last AWMP (2005).

[5] WUE Improvements expected in 2017 (five years in the future) and 2012 (ten years in the future), relative to level of implementation in recent years.

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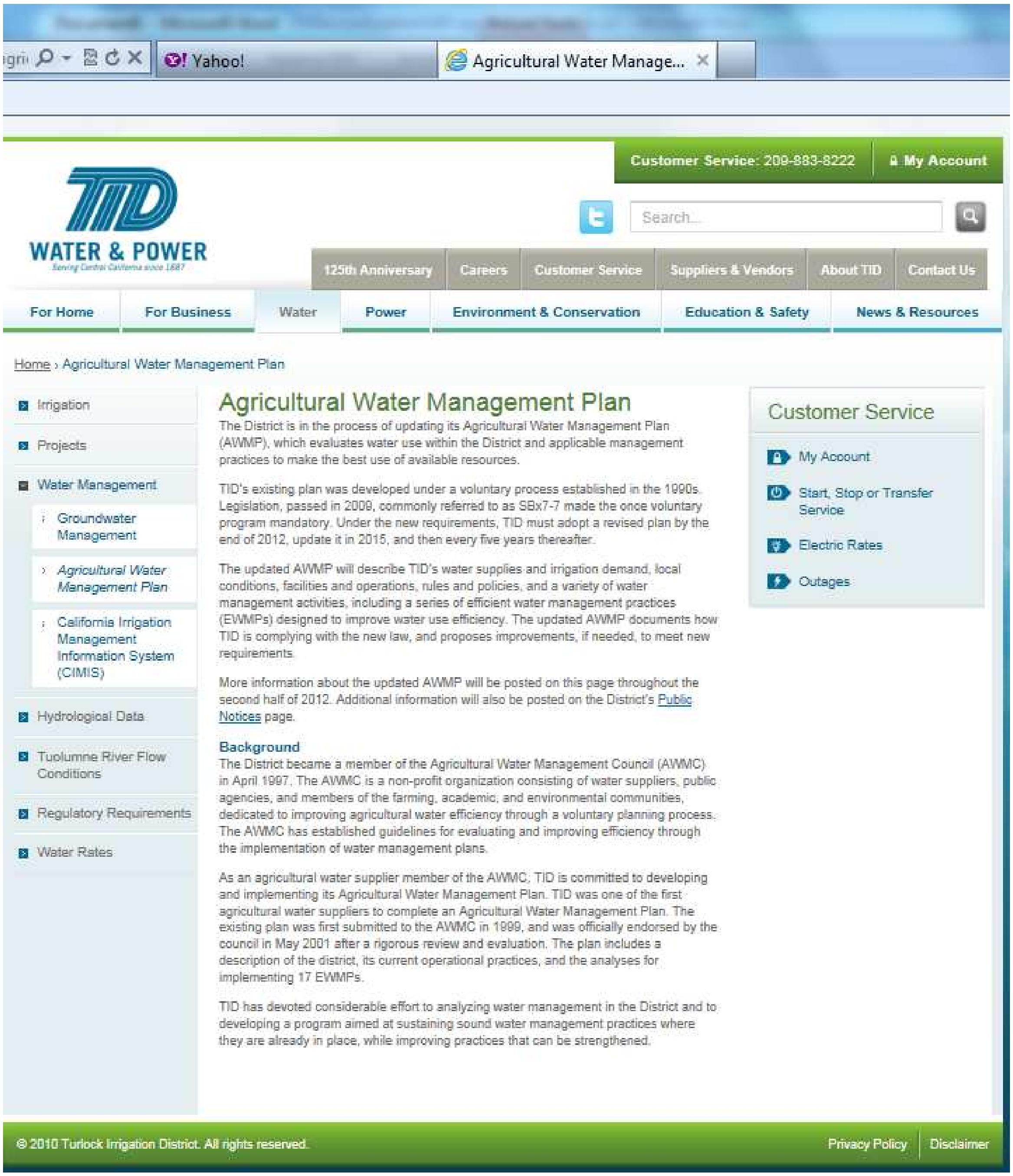
Appendix A
PUBLIC OUTREACH AND RESOLUTION ADOPTING PLAN

TID Website Information regarding Draft AWMP – To Be Updated after AWMP is Adopted

http://www.tid.com/water/water-management/agricultural-water-management-plan


Yahoo! | Agricultural Water Manage...

Customer Service: 209-883-8222 | My Account

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Home › Agricultural Water Management Plan

- Irrigation
- Projects
- Water Management
  - Groundwater Management
  - *Agricultural Water Management Plan*
  - California Irrigation Management Information System (CIMIS)
- Hydrological Data
- Tuolumne River Flow Conditions
- Regulatory Requirements
- Water Rates

Agricultural Water Management Plan

The District is in the process of updating its Agricultural Water Management Plan (AWMP), which evaluates water use within the District and applicable management practices to make the best use of available resources.

TID's existing plan was developed under a voluntary process established in the 1990s. Legislation, passed in 2009, commonly referred to as SBx7-7 made the once voluntary program mandatory. Under the new requirements, TID must adopt a revised plan by the end of 2012, update it in 2015, and then every five years thereafter.

The updated AWMP will describe TID's water supplies and irrigation demand, local conditions, facilities and operations, rules and policies, and a variety of water management activities, including a series of efficient water management practices (EWMPs) designed to improve water use efficiency. The updated AWMP documents how TID is complying with the new law, and proposes improvements, if needed, to meet new requirements.

More information about the updated AWMP will be posted on this page throughout the second half of 2012. Additional information will also be posted on the District's Public Notices page.

Background

The District became a member of the Agricultural Water Management Council (AWMC) in April 1997. The AWMC is a non-profit organization consisting of water suppliers, public agencies, and members of the farming, academic, and environmental communities, dedicated to improving agricultural water efficiency through a voluntary planning process. The AWMC has established guidelines for evaluating and improving efficiency through the implementation of water management plans.

As an agricultural water supplier member of the AWMC, TID is committed to developing and implementing its Agricultural Water Management Plan. TID was one of the first agricultural water suppliers to complete an Agricultural Water Management Plan. The existing plan was first submitted to the AWMC in 1999, and was officially endorsed by the council in May 2001 after a rigorous review and evaluation. The plan includes a description of the district, its current operational practices, and the analyses for implementing 17 EWMPs.

TID has devoted considerable effort to analyzing water management in the District and to developing a program aimed at sustaining sound water management practices where they are already in place, while improving practices that can be strengthened.

Customer Service

- My Account
- Start, Stop or Transfer Service
- Electric Rates
- Outages

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Table A.1. TID Ag Water Management Plan - Outreach/Distribution List

Agency	Department	Mailing Street Address	City	State	Zip	Zip +4	Notice of Intent Letter	Public Hearing Notice Letter	Draft Plan	Plan
Stanislaus County	Environmental Resources Dept	3800 Cornucopia Way, Suite C	Modesto	CA	95358	9494	X	X		X
Merced County	Environmental Health Dept	260 E 15th St	Merced	CA	95341	6216	X	X		X
City of Turlock	Municipal Services	156 S. Broadway, Suite 270	Turlock	CA	95380	5461	X	X		X
City of Modesto	Utility Planning & Projects Dept	PO Box 642	Modesto	CA	95354	0642	X	X		X
City of Hughson	Public Works	PO Box 9	Hughson	CA	95326	0009	X	X		X
City of Ceres		2220 Magnolia St	Ceres	CA	95307	3209	X	X		X
Keyes CSD		PO Box 699	Keyes	CA	95328	0699	X	X		X
Denair CSD		PO Box 217	Denair	CA	95316	0217	X	X		X
Delhi CWD		PO Box 639	Delhi	CA	95315	639	X	X		X
Hilmar CWD		8319 Lander Ave	Hilmar	CA	95324	8324	X	X		X
Eastside WD		PO Box 280	Denair	CA	95316	0280	X	X		X
Ballico-Cortez WD		12724 Sunny Acres Ave	Turlock	CA	95380	9028	X	X		X
DWR	Ag WUE Statewide IWM - WUE Branch	PO Box 942836	Sacramento	CA	94236	0001				X
LAFCo – Stanislaus Co.		1010 10th St, 3rd Floor	Modesto	CA	95354	0859				X
LAFCo – Merced Co.		2222 M St	Merced	CA	95340	3729				X
California State Library	Gov’t Publication Section	PO Box 942837	Sacramento	CA	94237	0001				X

Agency	Department	Mailing Street Address	City	State	Zip	Zip +4	Notice of Intent Letter	Public Hearing Notice Letter	Draft Plan	Plan
Turlock Public Library		550 Minaret Ave	Turlock	CA	95380	4137			X	X
Ceres Public Library		2250 Magnolia St	Ceres	CA	95307	3209				X
Denair Public Library		4801 Kersey Rd	Denair	CA	95316	9350				X
Hughson Public Library		2412 3rd St, Suite A	Hughson	CA	95326	9310				X
Keyes Public Library		1500 I Street	Modesto	CA	95354	1120				X
Delhi Educational Park Community Library		16881 W Schendel Ave	Delhi	CA	95315	9543				X
Irwin-Hilmar Public Library		20041 Falke St	Hilmar	CA	95324	9778				X
TID Website									X	X

CSD = Community Services District
CWD = County Water District
WUE = Water Use Efficiency
IWM = Integrated Water Management

Example Notice of Intent Letter to Local Public Agencies

WATER & POWER
Serving Central California since 1887

Board of Directors
Joe Alamo
Charles Fernandes
Michael Frantz
Ron Macedo
Rob Santos

August 28, 2012

John Aud
Stanislaus County
Environmental Resources Dept
3800 Cornucopia Way, Ste C
Modesto, CA 95358-9494

Dear John Aud:

RE: Notice of Intent to Adopt Update to Agricultural Water Management Plan

This letter serves as notice that the Turlock Irrigation District (TID) intends to adopt an update to its Agricultural Water Management Plan (AWMP). A hearing will be scheduled within the November/December 2012 timeframe to receive comments. Prior to the formal review process, comments may be submitted in writing to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Please refer to our website www.tid.com/AWMP for updates on the process and posting of the draft plan when it becomes available. Following the public hearing, the TID Board of Directors will consider the comments received, and may consider adopting the plan on the day of the hearing.

Should you have any questions, please do not hesitate to contact Debbie Liebersbach at (209) 883-8428, or dliebersbach@tid.org. Thank you.

Sincerely,

Steve Boyd
Director of WR&RA

Turlock Irrigation District
333 East Canal Drive, P.O. Box 949, Turlock, CA 95381-0949
Serving portions of Stanislaus, Merced and Tuolumne Counties

PH: 209.883.8300
www.tid.com

Copy of Notice of Intent – Affidavit of Publication – Turlock Journal - September 2012

Affidavit of Publication

PUBLIC NOTICE
NOTICE OF INTENT TO UPDATE
AGRICULTURAL WATER MANAGEMENT PLAN

STATE OF CALIFORNIA
County of Stanislaus } **ss**

MAUREEN JERNER

of the said County, being duly sworn, deposes and says:
THAT she is and at all times herein mentioned was a citizen of the United States, over the age of twenty-one years, and that she is not a party to, nor interested in the above entitled matter; that she is the Legal Clerk of the Turlock Daily Journal, a newspaper of general circulation, printed and published in the City of Turlock, County of Stanislaus, and which newspaper is published for the dissemination of local news and intelligence of a general character, and which newspaper at all times herein mentioned had and still has a bona fide subscription list of paying subscribers, and which newspaper has been established and published at regular intervals in the said City of Turlock, County of Stanislaus, for a period exceeding one year next preceding the date of publication of the notice hereinafter referred to; and which newspaper is not devoted to nor published for the interests, entertainment, or instruction of a particular class, profession, trade, calling, race or denomination, or any number of same; that the notice, of which the annexed is a printed copy and which is hereby made a part of this affidavit, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following date, to-wit:

SEPTEMBER 12, 15, 19, 22, 2012

I certify (or declare) under penalty of perjury that the foregoing is true and correct. This 22nd day of SEPTEMBER, 2012

AFFIDAVIT OF PUBLICATION

PUBLIC NOTICE
NOTICE OF INTENT TO UPDATE
AGRICULTURAL WATER MANAGEMENT PLAN

Notice of Intent to Update Agricultural Water Management Plan
The Turlock Irrigation District (TID) is in the process of updating its Agricultural Water Management Plan (AWMP). The Public Review Draft of the AWMP will be available for review by October 31, 2012. Copies of the draft plan will be available at the TID main office (333 E. Canal Dr., Turlock, CA 95380), at the Turlock Public Library (559 Minaret Ave., Turlock, CA 95380) or online at www.tid.com/AWMP .
Publish: 9/12, 9/15, 9/19 & 9/22/2012

Maureen Jerner

PRINCIPAL CLERK OF THE PRINTER

Copy of Notice of Intent – Declaration of Publication – Modesto Bee - September 2012

DECLARATION OF PUBLICATION
(C.C.P. S2015.5)

COUNTY OF STANISLAUS
STATE OF CALIFORNIA

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am a printer and principal clerk of the publisher of
THE MODESTO BEE,
which has been adjudged a newspaper of general circulation by the Superior Court of the County of **STANISLAUS,** State of California, under the date of **February 25, 1951, Action No. 46453.** The notice of which the annexed is a printed copy has been published in each issue thereof on the following dates, to wit:

SEPTEMBER 12, 15, 19, 22, 2012

Notice of Intent to Update Agricultural Water Management Plan

The Turlock Irrigation District (TID) is in the process of updating its Agricultural Water Management Plan (AWMP). The Public Review Draft of the AWMP will be available for review by October 31, 2012. Copies of the draft plan will be available at the TID main office (333 E. Canal Dr., Turlock, CA 95380), at the Turlock Public Library (559 Minaret Ave., Turlock, CA 95380) or online at www.tid.com/AWMP.
MOD-15115 9/12, 15, 19, 22

I certify (or declare) under penalty of perjury that the foregoing is true and correct and that this declaration was executed at
MODESTO, California on

SEPTEMBER 22, 2012

Marlyn Gonzalez

(Signature)

Copy of Notice of Intent – Declaration of Publication – Merced Sun-Star - September 2012

Story #15115 System MODZ by MCNAMARA Time

Name TURLOCK IRRIGATION DIS Phone 2098838310
Address PO BOX 949 Account 8838310TUR
Class 8000 Times 4 Start 9/12/12 Stop 9/22/12
Total Cost 155.52 Total Paid Rep MCNAMARA
Lines 13 AD COPY ENLARGED TO 150% > LIVEPAG
__________ AD COPY __________

Notice of Intent to Update Agricultural Water Management Plan

The Turlock Irrigation District (TID) is in the process of updating its Agricultural Water Management Plan (AWMP). The Public Review Draft of the AWMP will be available for review by October 31, 2012. Copies of the draft plan will be available at the TID main office (333 E. Canal Dr., Turlock, CA 95380), at the Turlock Public Library (559 Minaret Ave., Turlock, CA 95380) or online at www.tid.com/AWMP.
MOD-15115 9/12, 15, 19, 22

Example of Public Hearing Notice Letter to Local Public Agencies

WATER & POWER
Serving Central California since 1887

Board of Directors:
Joe Alamo
Charles Fernandes
Michael Frantz
Ron Macedo
Rob Santos

November 20, 2012

Michael Cooke
City of Turlock
156 S. Broadway, Ste 270
Turlock, CA 95380-5461

Dear Michael Cooke,

RE: Update to the TID Agricultural Water Management Plan - Public Hearing Notice

The Turlock Irrigation District (TID) is scheduled to hold a review and public comment period on the proposed update to the TID Agricultural Water Management Plan (AWMP) from November 21, 2012 through December 11, 2012. A public hearing is scheduled to be held at 9:00AM on December 11, 2012 in the TID Board Room, located at 333 East Canal Drive, Turlock, CA 95380. At the hearing, the TID Board will receive public comments on the draft AWMP, prior to consideration and possible adoption of the AWMP. All persons interested in this matter should appear at the public hearing to comment, or submit written comments as described below.

The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. Copies of the draft plan are available for review at the following locations:

- Turlock Public Library located at 550 Minaret Ave. in Turlock, CA
- Turlock Irrigation District office located at 333 E. Canal Dr. in Turlock, CA
- Turlock Irrigation District website: www.tid.com/AWMP

Any comments prior to the hearing should be submitted to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Any questions regarding the draft AWMP or the adoption process should be directed to Debbie Liebersbach at (209) 883-8428 or dcliebersbach@tid.org.

Sincerely,

Steven Boyd
Director of WR&RA

Turlock Irrigation District
333 East Canal Drive, P.O. Box 949, Turlock, CA 95381-0949
Serving portions of Stanislaus, Merced and Tuolumne Counties

PH: 209.883.8300
www.tid.com

Public Hearing Notice

Notice of Public Hearing

Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing
Tuesday, December 11, 2012 at 9:00AM

Regarding:
2012 Agricultural Water Management Plan

Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2012. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP.

A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website (www.tid.com/AWMP). Written comments, submitted prior to the hearing, should be directed to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Comments may also be provided at the hearing.
If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.

Copy of Hearing Notice – Merced Sun-Star – Various dates November24-December 8, 2012

Declaration of Publication

(2015.5 C.C.P)

STATE OF CALIFORNIA)
) ss.
County of Merced)

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer of the Merced Sun-Star, a newspaper of general circulation, printed and published in the City of Merced, County of Merced, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Merced, State of California, under the date of July 14, 1964, Case Number 33224 that the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

NOVEMBER 24, 28, DECEMBER
1, 5, 8, 2012

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Marilyn Gonzalez

Signature

Date: DECEMBER 8, 2012

This space reserved for County Clerk's Filing Stamp

Notice of Public Hearing
Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing
Tuesday, December 11, 2012 at 9:00AM
Regarding:
2012 Agricultural Water Management Plan
Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2012. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP.
A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website (www.tid.com/AWMP). Written comments, submitted prior to the hearing, should be directed to:
Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381
Comments may also be provided at the hearing.
If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.
SS-129468 11/24, 28, 1, 5, 8

Proof of Publication - Merced Sun-Star, P.O. Box 739, Merced, California 95341 - Phone 722-1511 Adjudged a newspaper of general circulation by court decree No. 33224 dated July 14, 1964

Copy of Hearing Notice – Modesto Bee – Various dates November24-December 8, 2012

DECLARATION OF PUBLICATION
(C.C.P. S2015.5)

COUNTY OF STANISLAUS
STATE OF CALIFORNIA

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am a printer and principal clerk of the publisher of
THE MODESTO BEE,
which has been adjudged a newspaper of general circulation by the Superior Court of the County of **STANISLAUS,** State of California, under the date of **February 25, 1951, Action No. 46453.** The notice of which the annexed is a printed copy has been published in each issue thereof on the following dates, to wit:

NOVEMBER 24, 29, DECEMBER 1, 5, 8, 2012

I certify (or declare) under penalty of perjury that the foregoing is true and correct and that this declaration was executed at **MODESTO,** California on

DECEMBER 8, 2012

Marilyn Gonzalez

(Signature)

Notice of Public Hearing

Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing **Tuesday, December 11, 2012 at 9:00AM**-Regarding:**2012 Agricultural Water Management Plan** Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2012. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP.A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website (www.tid.com/AWMP). Written comments, submitted prior to the hearing, should be directed to:Debbie LiebersbachTurlock Irrigation DistrictP.O. Box 949Turlock, CA 95381Comments may also be provided at the hearing.If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.
MOD-2818 11/24, 29, 1, 5, 8

Copy of Hearing Notice – Turlock Journal – Various dates November24-December 8, 2012

Affidavit of Publication

PUBLIC NOTICE
NOTICE OF PUBLIC HEARING
2012 AGRICULTURAL WATER
MANAGEMENT PLAN

STATE OF CALIFORNIA,
County of Stanislaus

Karrie Clinkenbeard

Of the said County, being duly sworn, deposes and says:

I am a citizen of the United States and a resident of the county aforesaid; I am over the age of twenty-one years, and not a party to or interested in the above entitled matter. I am the principal clerk of THE TURLOCK DAILY JOURNAL, 138 South Center Street, Turlock, California, a newspaper of general circulation, published in Turlock, California in the City of Turlock, County of Stanislaus, and which newspaper has been adjudged a newspaper of general circulation, by the Superior Court of the County of Stanislaus, State of California. That the notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

NOVEMBER 24TH & 28TH
DECEMBER 1ST & 8TH, 2012

I certify (or declare) under penalty of perjury that the foregoing is true and correct. This 10th day of December, 2012

Principal Clerk of the Printer

PUBLIC NOTICE
NOTICE OF PUBLIC HEARING
2012 AGRICULTURAL WATER
MANAGEMENT PLAN

Notice of Public Hearing
Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing Tuesday, December 11, 2012 at 9:00AM

Regarding:
2012 Agricultural Water Management Plan

Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2012. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP.

A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website (www.tid.com/AWMP). Written comments, submitted prior to the hearing, should be directed to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Comments may also be provided at the hearing. If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.
TJ#12-809

Resolution Adopting AWMP – December 11, 2012

RESOLUTION NO. 2012 - 71

RESOLUTION ADOPTING THE TURLOCK IRRIGATION DISTRICT AGRICULTURAL WATER MANAGEMENT PLAN WHICH WOULD AMEND AND SUPERSEDE THE EXISTING AGRICULTURAL WATER MANAGEMENT PLAN

WHEREAS, the Board of Directors of the Turlock Irrigation District adopted the existing Agricultural Water Management Plan in July 1999 pursuant to the Water Code Section 10900 et. seq.; and

WHEREAS, staff has prepared an update to the Plan, pursuant Section 10800, et. seq., Section 10900 and Section 10608.48 of the Water Code, including recent modifications effective November 2009; and

WHEREAS, the California Water Code, as amended by Senate Bill x7-7 in 2009, requires agricultural water suppliers to prepare and adopt Agricultural Water Management Plans on or before December 31, 2012; and

WHEREAS, the District has held a properly noticed public hearing to receive comments on the adoption of the proposed revisions to the Agricultural Water Management Plan as required by Sections 10821 and 10841 of the Water Code and Section 6066 of the Government Code; and

WHEREAS, at the public hearing, there were no written or verbal objections to the plan; and

WHEREAS, the California Environmental Quality Act (CEQA) and the Water Code exempts certain projects from the environmental review process; and

WHEREAS, staff has conducted a review of the Agricultural Water Management Plan and CEQA and has presented that review to the Board.

NOW, THEREFORE, BE IT HEREBY RESOLVED by the Board of Directors of the Turlock Irrigation District that:

1. The findings and evidence set forth in Attachment A are hereby adopted.

2. The Board finds that the project is exempt from CEQA and the Executive Secretary of the Board of Directors is authorized and directed to sign and file a notice of exemption for the project pursuant to the requirements of CEQA.

3. The Turlock Irrigation District Agricultural Water Management Plan as presented and prepared in accordance with Senate Bill x7-7 is adopted and supersedes all previous agricultural water management plans.

4. The General Manager or his designee is directed to submit copies of the plan, no later than 30 days from this date, to the various agencies and entities as specified in California Water Code Section 10843.

5. The Agricultural Water Management Plan shall be posted on the Turlock Irrigation District web site, and made available for public review, no later than 30 days from this date.

Moved by Director Macedo, seconded by Director Santos, that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes:	Directors Fernandes, Santos, Alamo, Macedo, Frantz
Noes:	Directors None
Absent:	Directors None

The President declared the resolution adopted.

I, Tami Wallenburg, Executive Secretary of the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 11th day of December, 2012.

Executive Secretary of the Board of Directors of the Turlock Irrigation District

ATTACHMENT A

CALIFORNIA ENVIRONMENTAL QUALITY ACT REVIEW:

AGRICULTURAL WATER MANAGEMENT PLAN

The Turlock Irrigation District (TID) finds that the Agricultural Water Management Plan (AWMP) is statutorily exempt from the California Environmental Quality Act (CEQA). The criteria and applicability of the exemption is discussed in the paragraphs below.

Water Code – Statutory Exemption

Section 10851 of the California Water Code provides an exemption from CEQA for preparation and adoption of plans. Section 10851 states:

> *The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public resources Code) does not apply to the preparation and adoption of plans prepared and adopted under this part. Nothing in this part exempts projects for implementation of the plan or for expanded or additional water supplies from the California Environmental Quality Act.*

SBx7-7 (passed in 2009) amended Section 10800 of the California Water Code (10851 falls under this section), making AWMPs a requirement. TID's AWMP was prepared according to the requirements of SBx7-7 and is therefore exempt from CEQA.

Recommendation

The TID Agricultural Water Management Plan is exempt from further CEQA review because it falls under a statutory exemption. It is recommended that the TID staff obtain authorization to file a Notice of Exemption and submit the necessary paperwork with the County Clerk for Merced and Stanislaus counties upon adoption of the AWMP.

Appendix B
TURLOCK GROUNDWATER BASIN GROUNDWATER MANAGEMENT PLAN

TURLOCK GROUNDWATER BASIN

Groundwater Management Plan

Prepared for.

Turlock Irrigation District
333 East Canal Drive/P.O. Box 949
Turlock, CA 95381

March 18, 2008

Prepared by.

Turlock Groundwater Basin Association

The Turlock Groundwater Basin Groundwater Management Plan (GWMP) can be found online at:

http://www.tid.com/sites/default/files/documents/tidweb_content/Groundwater%20Management%20Plan.pdf

A copy of the GWMP is also included with this AWMP on a CD.

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Appendix C
EXAMPLE NEWSLETTER

A Publication for Turlock Irrigation District Water Users

the Grower

Vol. 24 • No. 2 | August 2012

TID updating Ag Water Management Plan

Turlock Irrigation District is in the process of updating its Agricultural Water Management Plan (AWMP), which evaluates water use within the District and applicable management practices to make the best use of available resources.

TID's existing plan was developed under a voluntary process established in the 1990s. Legislation, passed in 2009, commonly referred to as SBx7-7 made the once voluntary program mandatory. Under the new requirements, TID must adopt a revised plan by the end of this year, update it in 2015, and then every five years thereafter.

The AWMP will describe TID's water supplies and irrigation demand, local conditions, facilities and operations, rules and policies, and a variety of water management activities, including a series of efficient water management practices (EWMPs) designed to improve water use efficiency. The AWMP documents how TID is complying with the new law, and proposes improvements, if needed, to meet new requirements.

Volumetric pricing and water measurement are two examples of EWMPs. TID adopted a new volumetric pricing structure, effective in 2013, to comply with SBx7-7 on June 12. The AWMP will describe the new pricing structure, as well as the District's plans for complying with increased water measurement accuracy and reporting, required by SBx7-7.

Another goal of SBx7-7 is to make water management data and information more readily available. AWMPs are now required to be posted on the Internet, and submitted to various local and state agencies, including the Department of Water Resources (DWR), and local urban water suppliers. DWR will report to the legislature in 2013 regarding the status of ag water management practice implementation statewide, and make recommendations on suggested improvements.

The current schedule has a draft plan for the TID Board's consideration at the end of November. Although time consuming and costly to implement, completing these planning processes, implementing efficient water management practices, and documenting their effectiveness are important steps for protecting the District's water supplies.

More information on the AWMP and EWMPs, including water measurement and pricing, will be provided in the coming months and years through *The Grower* newsletter articles like this one, and online at **www.tid.com/AWMP**.

For questions about the TID plan, or EWMPs, contact Debbie Liebersbach at (209) 883-8428.

October 10
Final day of irrigation season

Throughout November
Water Use Statements mailed

December 20
Water transfers must be completed

Interested in receiving The Grower newsletter **via email rather than a printed copy?** Please contact us via email at info@tid.org or by calling 209.883.8448.

INSIDE

TURLOCK IRRIGATION DISTRICT 125 YEARS

First full year of relicensing Don Pedro in the books

The year 2011 marked the Modesto and Turlock irrigation districts' first year of the Don Pedro relicensing process. The first year of the Integrated Licensing Process (ILP) was devoted to working closely with Relicensing Participants and the Federal Energy Regulatory Commission (FERC) to develop detailed studies to be conducted by the Districts to support the license application, which will be filed in April 2014. The year ended with FERC issuing its formal Study Plan Determination (SPD) on December 22.

The Districts will be conducting 35 different studies to investigate the project's potential to affect resources in the lower Tuolumne River and at and adjacent to the Don Pedro Reservoir. The Districts have retained the services of a number of experts in their respective fields to assist in the performance of these studies.

By the end of 2012, the Districts will have completed most of these studies, but some will continue into 2013.

Additional details regarding the Revised Study Plan (RSP), the SPD, upcoming meetings and more are available on the Don Pedro relicensing website. More information on Don Pedro, including a link to the relicensing site can be found at tid.com/don-pedro.

Irrigated Lands Regulatory Program update

By now, most growers are aware of the state's Irrigated Lands Regulatory Program (ILRP), also known as the "Ag Wavier", which began in 2003 and was extended by the Regional Water Board in 2006.

The original program required growers who discharged or had the potential to discharge to surface water to sign up for the program and either perform monitoring or join a coalition that did. The 2003 program only included discharges to surface water so growers who kept irrigation or storm water on their farm did not need to act.

The requirements are expected to be adopted by the Regional Board in October of this year.

In 2009, the Regional Board began work on a Long-term Irrigated Lands Program which will include potential discharges to surface water and groundwater. Last October, the Regional Water Board began holding meetings with the East San Joaquin Water Quality Coalition to try and develop workable requirements for the long-term program that affects this area. The requirements are expected to be adopted by the Regional Board in October of this year.

With the addition of groundwater to the existing surface water program, the Regional Board now considers any irrigated crop in the Central Valley to have a potential to discharge contaminants into groundwater aquifers, hence all growers will need coverage for their operations either through a coalition or individual permit with the Regional Board.

Key provisions of the new program include a requirement to submit farm evaluation plans to the coalition outlining practices used to protect surface and groundwater. Growers in high vulnerability groundwater areas, more than 60 percent of the coalition region, will also need to submit nitrogen budget sheets signed by a Certified Crop Advisor (CCA). These annual budgets will show if growers are applying nitrogen in balance with anticipated crop production needs determined through baseline information developed by commodity groups and the University of California.

What does this mean to growers? For growers currently enrolled with the Coalition, then not much will change. Growers not in the coalition will a have a "120-day membership holiday" where they can join without applying first to the state as is currently required. The membership holiday will start after the new regulations are passed in October 2012. Growers who have not enrolled should contact the East San Joaquin Coalition at www.esjcoalition.org for information on registering. The new program will also have an individual permit option for those who do not join the coalition.

Installing drip or micro systems? Give us a call

Growers who are considering installing a new type of irrigation system, such as drip or micro sprinklers that will have irrigation water supplied by TID, are asked to contact TID prior to installation.

Written authorization from the District is required for any new irrigation connections to ensure that the modifications comply with TID standards and water can be delivered to the location at the desired new flow rate. This is especially important for growers who are considering connecting to an improvement district pipeline. In many cases, older and/or busy improvement district lines are not capable of handling the longer duration irrigations associated with drip and micro systems.

Each new system must be evaluated on a case by case basis. For additional information, please contact TID's Water Distribution Department at (209) 883-8356.

TID WATER & POWER

Irrigation water rate structure to change formats in 2013

The pricing structure by which Turlock Irrigation District charges its irrigation water customers will change formats in 2013.

The change comes following a TID Board of Directors' vote in June, when the Board acted to charge customers based upon a volumetric pricing structure. Also reflected in the rates of this new structure is an increase that aims to narrow an annual $1 to $2 million gap that exists between water revenues and the costs associated with delivering water to customers.

The change to volumetric pricing comes in response to current California water conservation legislation. As an agricultural water provider, TID is required to have pricing that, in part, charges by the quantity of water delivered, also known as volumetric pricing. Starting in 2013, irrigators will be charged based upon either a normal year rate schedule or a dry year rate schedule that will be selected by the Board each year. The dry year schedule is needed to offset the increase in groundwater pumping costs to TID that occurs in dry years.

Starting in 2013, water customers will only pay for the water they receive. Under TID's existing pricing structure – a set allotment for all customers with water typically available over the allotment in normal water years – many growers pay for water they can't use and don't need.

Seventy-three percent of the time the allotment has been set at greater than 36 inches, while 50 percent of acres irrigated by TID use less than or equal to 33 inches.

This change to TID's irrigation water pricing structure comes on the heels of five public workshops held throughout TID's service area in April and a series of public presentations made on the topic at Board meetings in March and April of this year.

In 2013, TID irrigation water customers will only pay for the water they receive. Under TID's existing pricing structure many growers pay for water they can't use.

2013 Irrigation Rate Changes

WHAT: In compliance with state law, the TID Board of Directors voted to adjust the 2013 irrigation water rate structure. The rate structure for 2012 remains unchanged.

INFORMATION ON THE 2013 RATES: Visit www.tid.com/water/water-rates for more information on the cost of irrigation water in 2013, including rates schedules for normal and dry years.

WHY TWO TYPES OF RATE SCHEDULES? Irrigators will be charged based upon a normal year rate schedule or a dry year rate schedule. The dry year schedule is needed to offset the increase in groundwater pumping costs to TID that occurs in dry years.

More on the web: tid.com/water/water-rates

the Grower | August 2012

TURLOCK IRRIGATION DISTRICT 125 YEARS

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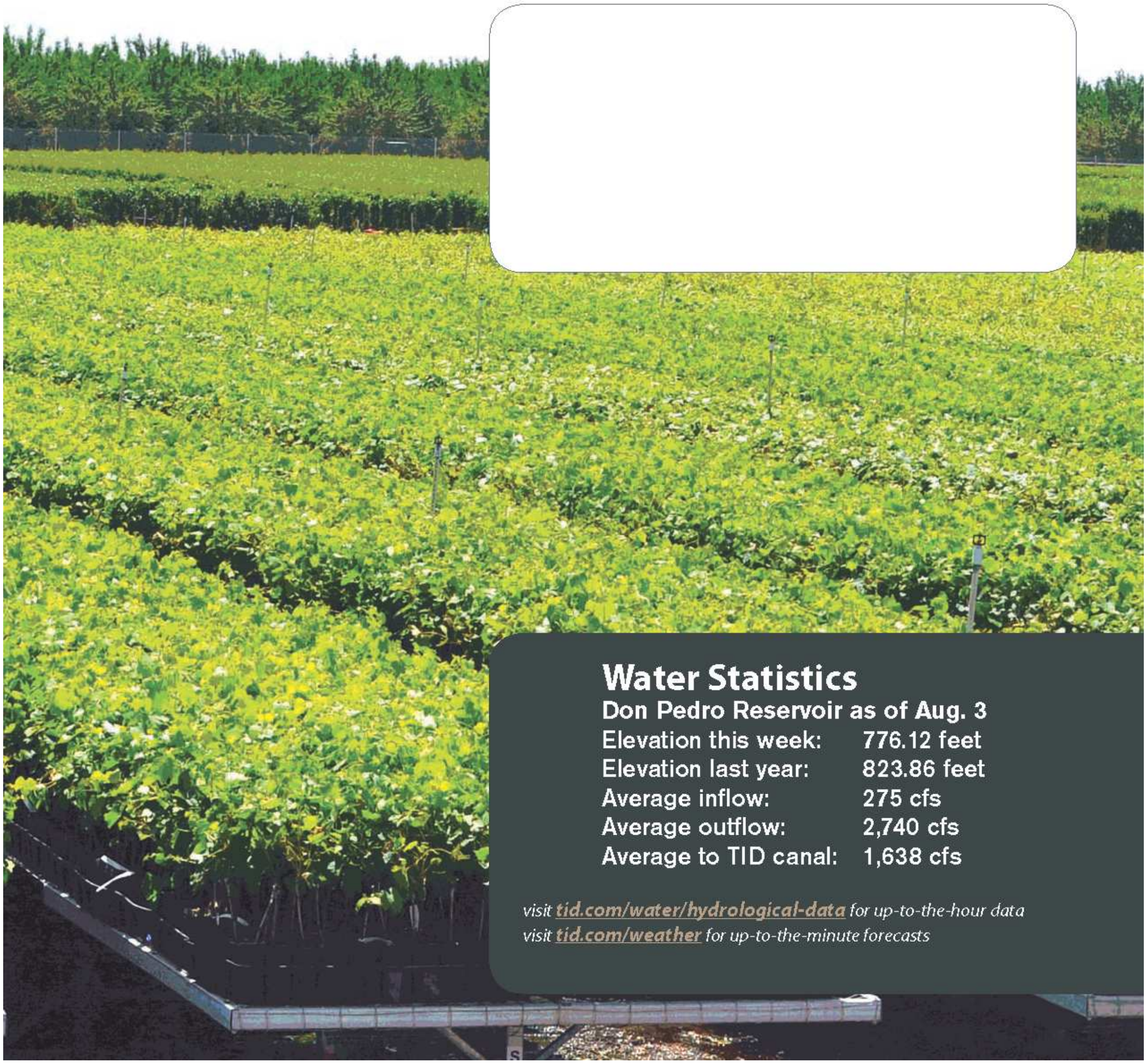

Water Statistics

Don Pedro Reservoir as of Aug. 3

Elevation this week:	776.12 feet
Elevation last year:	823.86 feet
Average inflow:	275 cfs
Average outflow:	2,740 cfs
Average to TID canal:	1,638 cfs

visit ***tid.com/water/hydrological-data*** *for up-to-the-hour data*
visit ***tid.com/weather*** *for up-to-the-minute forecasts*

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Appendix D
DISTRICT MAPS

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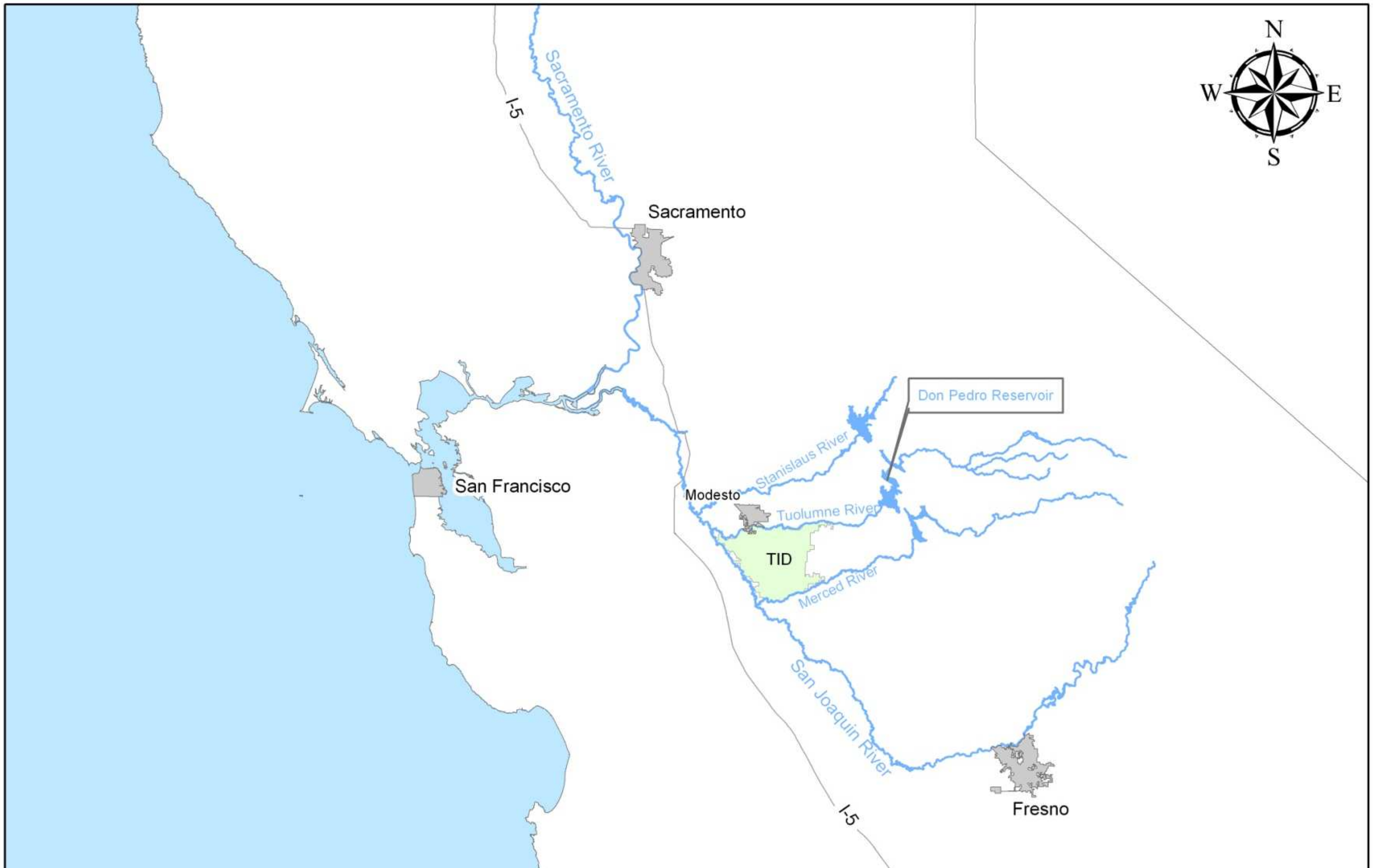

Figure 1: Area Map Turlock Irrigation District

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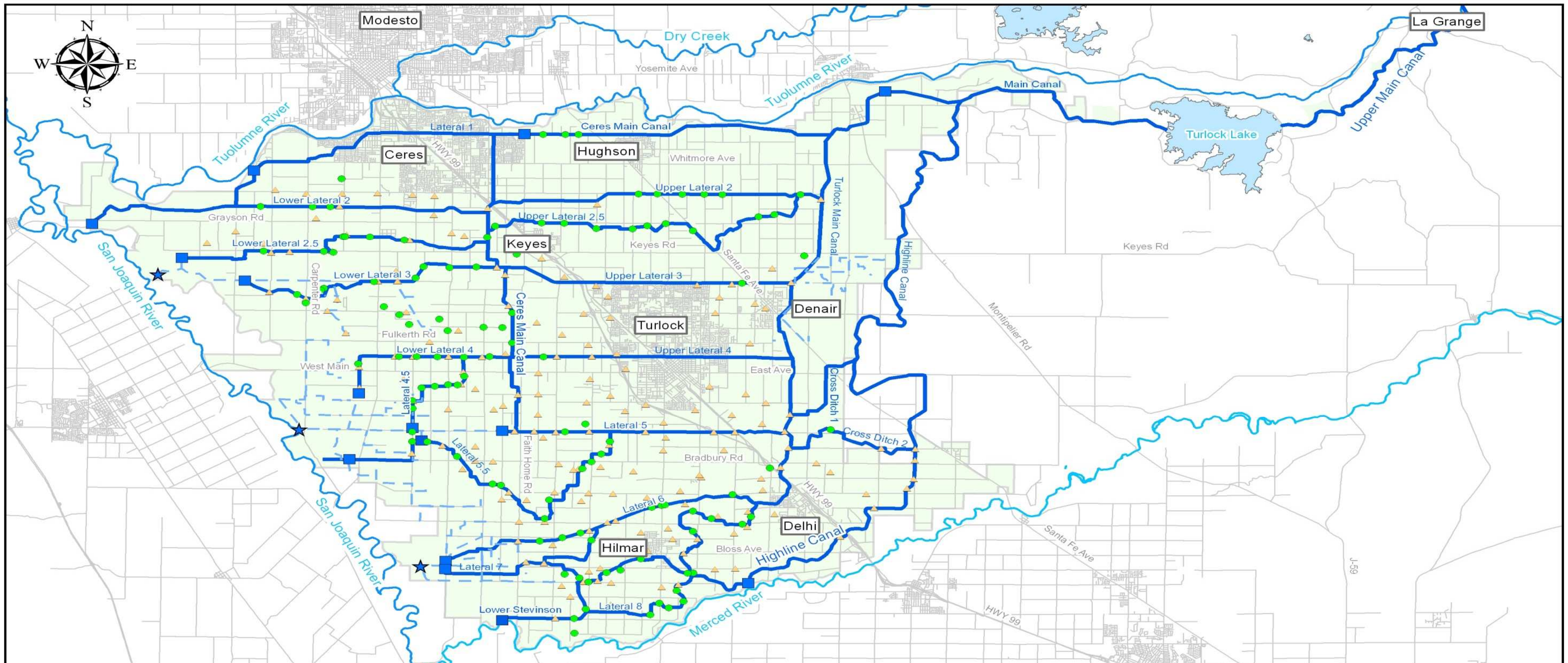

Figure 2: Map of the Turlock Irrigation District

Legend

- TID Canal
- Drain
- Canal Spill Location
- Drain Spill Location
- Rented Well
- TID Drainage Well
- TID Irrigation Service Boundary

0 1 2 4 6 8 10 Miles

WATER & POWER
Serving Central California since 1887

MJN 8/13/12

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Appendix E
Turlock Irrigation District Irrigation Rules

THE TURLOCK IRRIGATION DISTRICT
IRRIGATION RULES

EFFECTIVE, SEPTEMBER 30, 2003

REVISED, FEBRUARY 22, 2005

REVISED, JUNE 2, 2009

The Turlock Irrigation District Irrigation Rules can be found online at:

http://www.tid.org/sites/default/files/documents/tidweb_content/Irrigation%20Rules.pdf

A copy of the Turlock Irrigation District Irrigation Rules is also included with this AWMP on a CD

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Appendix F
AGRICULTURAL WATER MEASUREMENT CORRECTIVE ACTION PLAN

Agricultural Water Measurement Corrective Action Plan

According to Requirements of the

California Code of Regulations

Title 23. Waters Division 2.

Department of Water Resources

Chapter 5.1. Water Conservation Act of 2009

Article 2. Agricultural Water Measurement

Introduction

The Turlock Irrigation District (TID or District) recognizes the need for farm delivery measurement and uniform standards and procedures for measuring and recording farm water deliveries in order to: (1) provide cost-effective service to customers and (2) generate improved operational records for planning and analysis. Regulations requiring a specified level of delivery measurement accuracy were incorporated into California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597) in July 2012. Field investigations conducted over recent years indicate that TID's existing measurement devices, referred to as sidegates, and measurement methods are generally adequate for the aforementioned purposes, but that not all sidegates will satisfy the new accuracy standards required by 23 CCR §597.

As explained in the next section, 23 CCR §597 allows until December 31, 2015 to implement corrective actions for measurement devices that do not meet the required accuracy standards. This document describes TID's plan to implement corrective actions over the next three years in order to comply with 23 CCR §597 by December 31, 2015. As implementation of the plan proceeds, TID will continually assess progress and adapt the plan as necessary to ensure that compliance is achieved.

Applicability (23 CCR §597.1)

Briefly summarized, 23 CCR §597 requires that on or before July 31, 2012 agricultural water suppliers providing water to 25,000 irrigated acres or more measure the volume of water delivered to customers. Existing measurement devices must be certified to be accurate to within ±12 percent by volume (23 CCR §597.3(a)(1)). New or replacement measurement devices must be certified to be accurate to within ±5 percent by volume in the laboratory if using a laboratory certification or ±10 percent by volume in the field if using a non-laboratory certification (23 CCR §597.3(a)(2)). The regulation includes specific requirements for certifying and documenting accuracy for existing and new devices (23 CCR §597.4). Additionally, suppliers subject to the regulation are required to report certain information in their 2012 and subsequent Agricultural Water Management Plans (AWMP) (23 CCR §597.4(e)). If existing measurement devices are not sufficiently accurate, suppliers must include in their 2012 AWMPs a plan to for taking corrective action by December 31, 2015 to achieve compliance (23 CCR §597.4(e)(4)). TID serves more than 25,000 acres and is therefore subject to these regulations.

Existing Facilities

Distribution System

TID's canal system begins at La Grange Dam where water released from Don Pedro Reservoir for irrigation purposes is diverted into the TID Upper Main Canal for conveyance to Turlock Lake. Turlock Lake is an off-stream reservoir with a capacity of 45,600 acre-feet (AF). TID operates Turlock Lake to store and release irrigation water supplies, to balance irrigation deliveries with irrigation demands, and to minimize flow fluctuations in the District's irrigation canals and laterals.

From Turlock Lake, water is released into the Main Canal for distribution through a gravity flow system to downstream growers for irrigation purposes (Figure F.1). TID's conveyance and distribution system consists of approximately 230 miles of canals, of which 207 miles (90 percent) are fully or partially lined. Three main delivery canals generally run north to south with laterals running east to west from the canals. Upper laterals (i.e. laterals with higher elevation, generally in the eastern portion of the District) terminate at the lower canals and laterals (generally toward the west) so that potential lateral spillage is instead utilized for deliveries to lands served by the lower canals. Several interconnections between canals provide additional operational flexibility, enabling the District to capture and deliver water that could otherwise spill from the system.

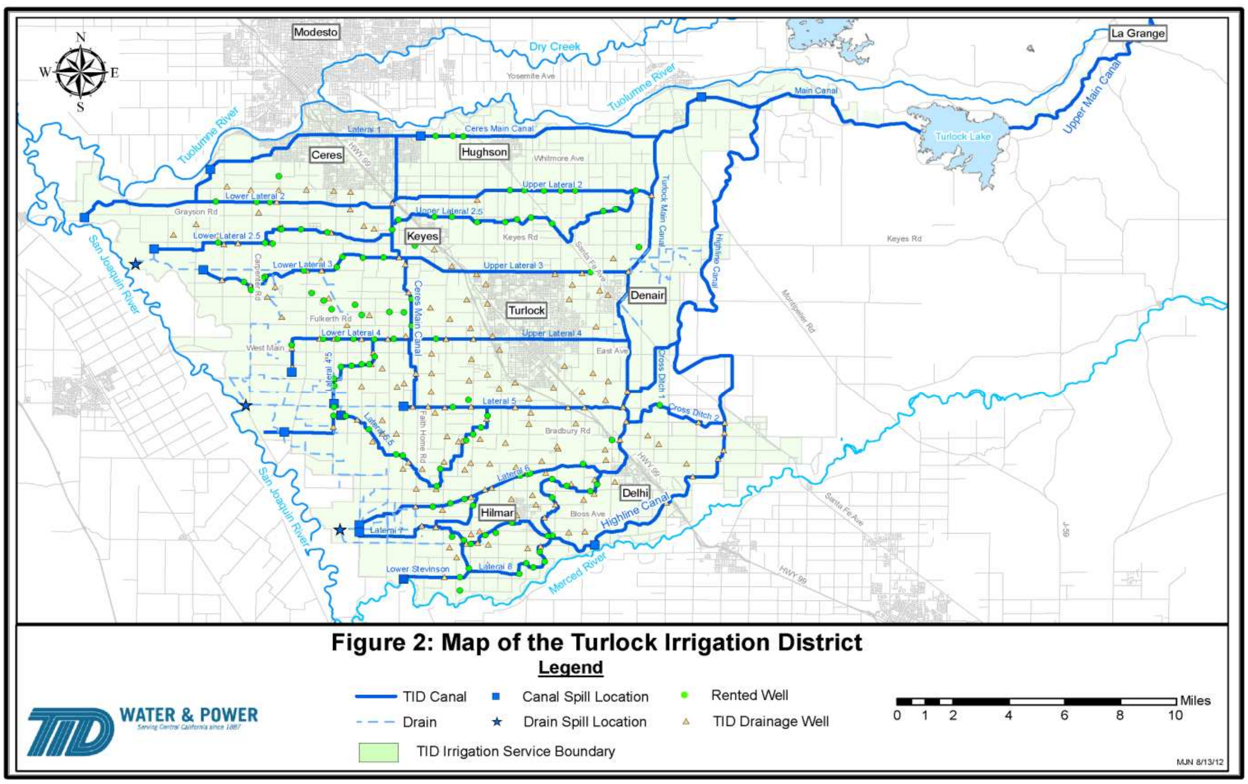

Figure F.1. TID Distribution System.

Groups of landowners have formed Improvement Districts (IDs) to construct and maintain the irrigation facilities needed to transport water from TID's canals and laterals to the landowner's parcels. On average, IDs are comprised of 13 parcels, with each parcel having an average size of 18 acres.

Irrigation Deliveries

Canal sidegates[1] are the delivery points through which water is delivered from TID canals and laterals to customers. TID customers are the individual landowners (or land tenants) to whom TID deliverers water, served either directly from the TID distribution system or through facilities owned by groups of landowners organized under IDs. TID measures water deliveries at the sidegate, where responsibility for water control and management is passed from TID to customers.

The predominant on-farm irrigation method in the TID service area is basin-check flood irrigation. The standard basin-check delivery rate (or "flood head") is 15 cubic feet per second (cfs) or 20 cfs, depending on the on-farm or system capacity. Customers typically receive a full standard flood head unless the conveyance system (open ditch or pipeline) lacks sufficient capacity. Growers are responsible for controlling their water while irrigating and then passing the head to the next grower, as instructed by the TID Water Distribution Operator (WDO).

In some cases, growers with pressurized micro-irrigation or sprinkler systems take a smaller flow rate (typically between 1-2 cfs), referred to as a "drip/micro head" while another grower takes a flood head. In these cases, the drip/micro head is estimated based on the grower's pump capacity and the remainder of the flow measured at the ID sidegate is charged to the flood head user.

Water deliveries to parcels typically occur on a rotational schedule with one parcel taking the full "head" of water delivered through the TID sidegate at a given time. The "head" of water is passed, or "rotated", from parcel to parcel by growers, with the delivery duration varying according to parcel size and other factors. In a few cases, sidegates have the capacity for two heads and the heads are divided at a point below the sidegate.

Water Orders

TID uses a restricted arranged demand system of water ordering and delivery with one parcel at a time taking the full "head" of water. Under this system irrigation frequency is arranged, flow rates are standardized, and the delivery duration is flexible. Cropping patterns in TID's irrigation service area are very diverse. For example, one sidegate may provide water to trees, vines, alfalfa, and field crops. An individual customer may adjust the duration and frequency of delivery and, rarely, the flow rate to meet crop needs. Customers are allowed to keep the water until the irrigation of their parcel(s) is complete.

Customers are billed for the total volume of water used, computed from the actual time of use rather than the time estimate given when the water order is placed. As described in the "Irrigation Deliveries" section above, each grower takes the full head. The WDO notifies each

[1] "Sidegate" is the term that is used in TID for the "delivery point" defined in 23 CCR§597 as "…the location at which the agricultural water supplier transfers control of delivered water to a customer or group of customers…." (23 CCR §597.2(a)(6))

grower with the name and contact information for the grower they will receive the water from and the grower to whom the water will be passed, when finished. As described above, customers with pressurized micro-irrigation and sprinkler systems typically require smaller flow rates than those used for flood irrigation. These smaller, non-standard flow rates are handled by growers placing orders with the TID Central Call Center and then communicating directly with the WDO to coordinate delivery.

In the early 1990's, TID software engineers created a proprietary system that has been updated as needed over time and is used by TID's Central Call Center to (1) track water orders, (2) schedule irrigation deliveries and (3) bill customers. This proprietary system is used to track and store irrigation start and stop times and is referred to as the TID "customer invoicing system."

Evaluation of Delivery Measurement Devices and Practices

Prior to the initial certification process (23 CCR§597.4a), the measurement accuracy of TID sidegate delivery measurement devices was evaluated. The results of this evaluation are discussed in this section.

As described previously, sidegates are the delivery points through which water is delivered from the TID system to customers. Sidegates are operated for measurement by setting the sidegate opening to deliver a standard flood head, based on the sidegate size and the difference between the water levels upstream and downstream of the sidegate. Historically, sidegate-specific gate openings required to deliver a standard flood head were determined from flow measurements made by trained TID employees using portable electromagnetic velocity meters. The sidegate openings are based on specific upstream and downstream water levels that are intended to and generally do remain steady during canal (also referred to as "lateral") operation. The sidegate-specific openings were compiled and provided to WDOs, who deliver the water, as well as to growers, who are able to check that they are receiving the standard flood head.

Each parcel within TID is associated with a specific sidegate with its specific opening and related flow rate. When growers complete irrigation events, they contact the WDO to report the irrigation event start and stop times. The WDO records the start and stop times on a water receipt and provides the information to the Central Call Center. The parcel specific flow rates are multiplied by the duration of each irrigation event to compute the volume of water delivered to each parcel. Growers are then billed for the volume of water used.

Using TID's sidegates to measure delivery volumes at the parcel level is complicated by two main factors:

- Downstream hydraulic conditions on sidegates can vary appreciably among parcels as the head is rotated and even for individual parcels as irrigation "sets" are changed, resulting in flow rate fluctuations.
- In some cases where sidegates discharge into pipelines, access to pipes needed to observe downstream water levels and for conducting flow verification is limited or impossible.

TID has completed independent current meter measurements at certain sidegates over the last 10 years in an effort to better understand the complicating factors noted above and to improve delivery measurement accuracy. Analysis of this sample of measurements indicates that many sidegates will not comply with 23 CCR §597. Additionally, TID realizes that with over 1,200 sidegates to be checked and a certain percentage to require corrective actions, it is not possible to design and implement the required modifications to all sidegates by the end of 2012. Therefore, TID has prepared this plan to be fully compliant with 23 CCR §597 by December 31, 2015 and, in its 2015 AWMP, will report the information specified in 23 CCR §597.4(e).

Delivery Measurement Corrective Action Plan (23 CCR §597.4(e)(4))

CORRECTIVE ACTION

Consistent with 23 CCR §597.4(e)(4), TID has identified corrective actions described below for its existing measurement devices. The corrective actions fall into two groups, one for flood deliveries, which will be made at sidegates, and another for pumped deliveries, which will be made at customer pump locations.

Flood Deliveries:

TID has developed two types of corrective actions for flood deliveries at TID sidegates (Table F.1). First, TID plans to install new continuous flow measurement devices on 125 sidegates that serve the largest IDs. By instrumenting fewer than 10% of the total sidegates in this manner, TID will continuously measure water deliveries to approximately 50 percent of the irrigated area. All new flow devices will be installed, maintained, operated and monitored per the manufacturer's recommendations. Second, for the more than 90% of sidegates that serve the remaining irrigated area, TID is planning to use the existing sidegates as the measurement device, but with corrective actions taken to ensure compliance with the regulation. The corrective action will involve independently measuring each sidegate to calibrate parcel-specific average flow rates under standard hydraulic conditions (upstream water level and sidegate opening) at each sidegate. Parcel-specific sidegate ratings will address the most significant existing measurement deficiency, which is accounting for different downstream water levels at sidegates as different parcels are served.

Table F.1. Summary of Corrective Actions and Associated Certification Approaches and Accuracy Standards for Flood Deliveries at TID Sidegates.

Corrective Action	Delivery Measurement Certification Approach	Accuracy Required (23 CCR §597.3a)	Estimated Number of Sidegates	Estimated Assessed Area Served, acres	Estimated Assessed Area Served, %
New Device--Continuous Flow Measurement Device	Laboratory Certification	+/- 5%	125	74,447	51%
Existing Device (sidegate)--Parcel Specific Average Flow Rate	Field Measurements	+/- 12%	1088	71,444	49%
Totals			1213	145,891	100%

Two measurement methods will be used to determine the parcel specific average flow rate for use with the existing sidegates. For sidegates serving more than three parcels and less than 300 total acres, a continuous flow measurement device will be installed temporarily and the average flow rate will be calculated for each parcel during one or more complete irrigation events. For sidegates serving one to three parcels where downstream hydraulic conditions, and consequently flow rate, are determined to not vary significantly during each irrigation event, parcel specific spot flow measurements will be made to determine the parcel specific average flow rate.

Pumped Deliveries:

Approximately 400 customer irrigation systems in TID receive surface water through on-farm booster pumps. TID plans to require these customers to install continuous recording flow meters with a laboratory certified accuracy of ±5 percent by volume, or better. All of these new flow devices will be installed, maintained, operated and monitored per the manufacturer's recommendations and will be inspected periodically by TID staff.

SCHEDULE (23 CCR §597.4(E)(4))

23 CCR §597.4(e)(4) requires an agricultural water supplier with existing water measurement devices out of compliance with §597.3 to submit a schedule for taking corrective action in three years or less (i.e. prior to December 31, 2015). TID's delivery measurement plan consists of the following tasks:

1. Initially classify sidegates into one of the two delivery flow measurement approaches.
2. Install continuous flow rate measurement devices on the turnouts that together account for delivery to about 50 percent of the assessed area.
3. Inspect continuous measurement devices installed on customer pumps
4. Collect flow data at remaining sidegates to determine parcel specific average flow rates for each parcel.
    a. Sidegates requiring temporary continuous flow measurement devices
        1. Install measurement devices
        2. Collect data
        3. Repeat for the next set of sidegates
    b. Complete current meter measurements for each parcel at each sidegate that does not require a temporary continuous flow measurement device
    c. Review and refine, if necessary, initial classification of sidegates based on data collected.
    d. Document parcel specific average flow rates and the associated sidegate openings in a database.
    e. Compute delivery volumes as the product of the parcel specific average flow rates and the duration of the irrigation events as determined by the reported start and stop times for each parcel.

TID has developed a three-year schedule to complete the tasks described above to complete the required corrective action (Figure F.2). The initial classification of sidegates by delivery flow measurement approach will be complete by the end of 2012. TID has already installed new continuous flow measurement devices at six sidegates for testing purposes. Because it is easier

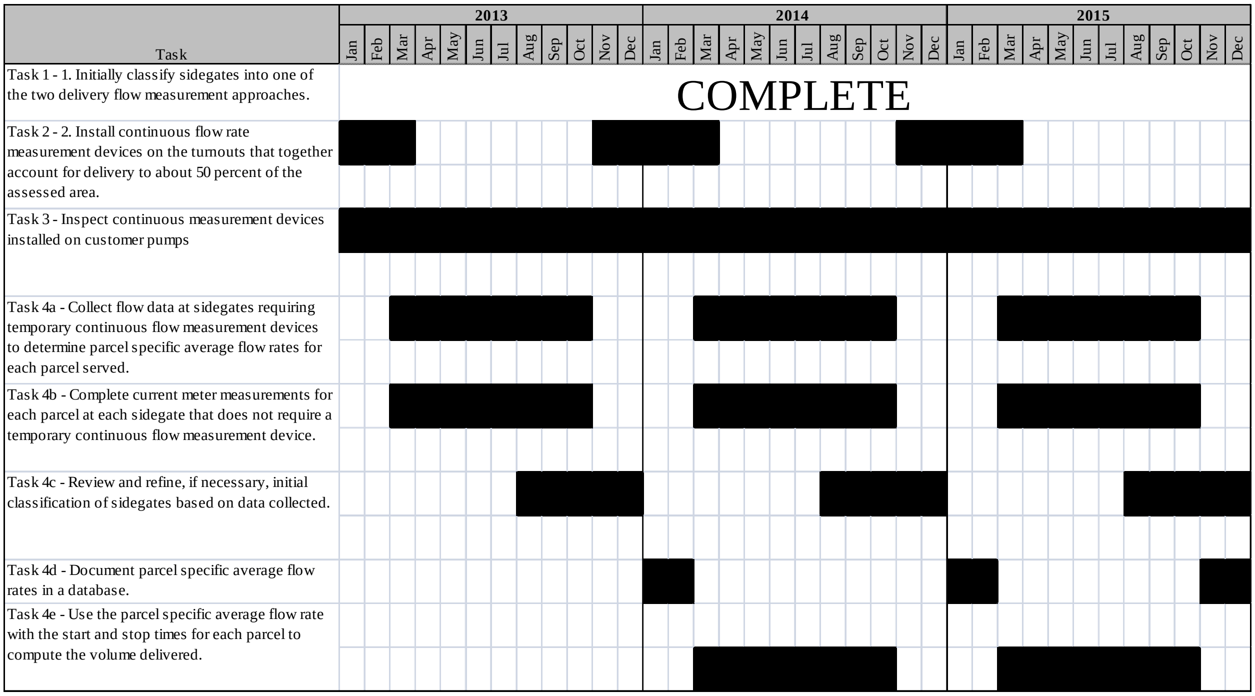

Figure F.2. Schedule for Completing Delivery Measurement Improvement Plan.

to install new flow measurement devices when there is no water in the canals, TID plans to install the majority of the new continuous flow measurement devices during the off-season.

Flow data to determine parcel specific average flow rates must be collected during the irrigation season. Temporary continuous flow measurement devices to be installed as described in Task 4a must be relocated three times each year to cover all the estimated 747 sidegates requiring these measurements (Figure F.3). TID plans to collect the necessary flow data during the 2013, 2014 and 2015 irrigation seasons. The District will begin analysis and review of the data and, if necessary, revision of sidegate classifications in August of each year. Analysis of data from each irrigation season will be used to assess the status of the corrective action plan and, if necessary, the plan will be adapted.

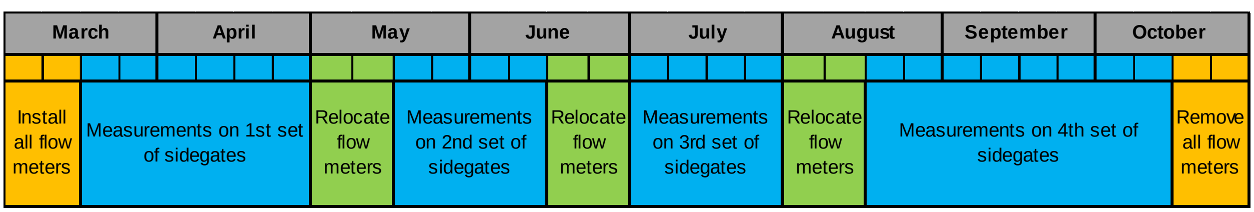

Figure F.3. Typical Schedule for Relocating Continuous Flow Measurement Devices (Task 4a) during the 2013, 2014 and 2015 Irrigation Seasons.

BUDGET (23 CCR §597.4(E)(4))

The total budget for the delivery measurement improvement plan is $8.02 million dollars, including a 20 percent cost contingency and $792,000 spent in 2012 (Table F.2). Excluding the cost contingency, one percent of the cost is for spot flow rate measurements to determine parcel specific average flow rates for each TID sidegate serving one to three parcels (Approach #1). Twenty-six percent of the cost is for temporary continuous flow rate measurements to determine

Table F.2. Estimated Budget for Delivery Measurement Corrective Action Plan.

	2012	2013	2014	2015	Total Cost
Approach #1: Spot flow measurement at each sidegate	$10,000	$40,000			$50,000
Approach #2: Average flow measurement at each sidegate	$250,000	$1,150,000	$557,400	$136,000	$2,093,400
Approach #3: Continuous flow measurement at each sidegate	$400,000	$400,000	$900,000	$800,000	$2,500,000
Seasonal staff		$125,360	$125,360	$125,360	$376,080
Subtotal	$660,000	$1,715,360	$1,582,760	$1,061,360	$5,019,480
20% Contingency	*$132,000*	*$343,072*	*$316,552*	*$212,272*	*$1,003,896*
Sidegate Cost	**$792,000**	**$2,058,432**	**$1,899,312**	**$1,273,632**	**$6,023,376**
Private Booster Pumps: Continuous flow measurement at		**$1,000,000**	**$1,000,000**		**2,000,000**
Total Cost	**$792,000**	**$3,058,432**	**$2,899,312**	**$1,273,632**	**$8,023,376**

parcel specific average flow rates for TID sidegates determined to require continuous flow measurements (Approach #2). Thirty-one percent of the cost of delivery measurement improvement is associated with purchasing and installing the estimated 125 new continuous flow measurement devices (Approach #3). The $10,000 cost estimate for each new continuous flow measurement device includes a local display, solar panel, vandalism enclosure and all required parts to install the device. Five percent of the cost is for labor and communications and vehicles supporting the labor. Twenty-five percent of the cost is for continuous flow measurement at private booster pumps. Initial preparations and equipment testing in 2012 required 10 percent of the total budgeted expenditures. Due to equipment purchases, 38 percent of the expenditures for the plan occur in 2013, with 36 and 16 percent expenditures in 2014 and 2015, respectively.

FINANCE PLAN (23 CCR §597.4(E)(4))

TID plans to raise water rates to generate sufficient revenue to include a budget line item in the 2013, 2014 and 2015 budgets to provide funds for the delivery measurement corrective action plan. A program to provide rebates to the growers who install flow measurement devices on private booster pumps within a specified time period is also being considered.

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