Agricultural Water Management Plan

Developed for the Department of Water Resources

By

The Merced Irrigation District

In compliance with the

Senate Bill (SB) X7-7 of 2009

Adopted by the MID Board of Directors

July 5, 2016

Preface

On September 3, 2013, the Merced Irrigation District (MID or District) prepared and adopted in Agricultural Water Management Plan (AWMP or Plan) in compliance with California law, SB X7-7 (2013 Plan) (see Resolution 2013-25). In accordance with law, the development of this update to the Districts previously adopted AWMP has provided MID with an opportunity to further gauge its performance in meeting the District's water resources management goals, which include providing a reliable, high quality and affordable water supply to its customers, which in turn benefits the entire region.

To support its water resources management goals, MID's water management practices are centered on its robust and effective conjunctive use activities and its long standing commitment to water conservation and system efficiency. The effectiveness of these management practices are assessed in this Plan by comparing key metrics to the 2013 Plan. In addition to the requirements outlined in SB X7-7, this plan also complies with the Governor's April 2015 Executive Order regarding agency development of a drought management plan.

There are several ongoing activities, both internal and external to MID, that may impact its management practices and key metric performances in future Plans. These activities and their potential impact, both positive and negative, are discussed in Section 1, Introduction.

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SECTION 1. INTRODUCTION

The Merced Irrigation District (MID, District, or Merced ID) has prepared this update to its previously adopted Agricultural Water Management Plan (AWMP or Plan) in compliance with the Water Conservation Act of 2009 (SB X7-7) and the Governor's April 2015 Executive Order. SB X7-7 has mandated certain agricultural water suppliers to meet the following requirements:

- Prepare and adopt an Agricultural Water Management Plan (AWMP)
- Implement Efficient Water Management Practices (EWMPs)
- Submit documentation for Agricultural Water Measurement Regulation compliance
- Submit an Aggregated Farm-Gate Delivery Report

This Plan is organized according to the framework indicated in SB X7-7 §10826 and includes a discussion of the implementation status for each of the EWMPs presented in SB X7-7 §10608.48. These EWMPs are grouped in the following two categories:

- Critical Efficient Water Management Practices
- Conditional Efficient Water Management Practices

As a conjunctive use district, one year would not adequately be reflective of MID operations. Therefore, for water balance purposes, the period between 2010 and 2015 was used to represent a continuous period experiencing different hydrologic water year types including critical dry years and wet years.

In addition to the mandatory components of the Plan, additional water resources management practices are discussed to serve as a backdrop to the AWMP. These practices are centered on MID's robust and effective conjunctive use activities, and its long standing commitment to water conservation and system efficiency. This discussion includes a background on the evolution of MID's management goals and foreseeable activities that may impact its future management activities.

1.1 MID Water Resources Management and Conjunctive Use

Merced ID is a conjunctive use district that has rights to surface water supplies and lies over a groundwater basin that has been severely impacted during the current 2012-2015 drought. MID owns and operates approximately 215 active conjunctively used groundwater wells. The vast majorities of Merced ID's conjunctive groundwater wells are left on stand-by and are only operated to provide a supplemental water supply during years of surface water shortages. Some groundwater wells are operated annually to serve high-ground parcels.

1.2 Background

Since Merced ID's formation in 1919, both surface water and groundwater sources have been conjunctively used to meet water supply demands in the basin. Originally, these demands were predominately for agricultural irrigation, although, over time, the magnitude of municipal and industrial pumping increased as the urban centers within Merced ID's territory grew.

Prior to the passage of Proposition 13 in 1978, MID assessed all landowners within the District uniformly, regardless of their use of surface water. This provided an incentive for irrigators to use District supplies (from both the Merced River and District wells). Following the passage of Proposition 13, the District began to charge for water service, first on a flat rate basis depending on allocation in a given year, and later on a volumetric basis. As an economic choice, some MID customers opted to develop and use groundwater because, in many places within the District, groundwater could be developed below the cost of District water.

During the course of the 1987-1992 drought, when surface water supplies were limited, rates for surface water supplies increased 44 percent and many MID customers constructed private groundwater wells for additional water supply. As would be expected, once an investment is made to construct a private well, the tendency is to use the well rather than surface water. This tendency was compounded by the growing use of low-volume, pressurized on-farm application systems, which are better adapted to groundwater sources than to surface water supplies. By the end of the 1987-1992 drought, groundwater elevations were generally declining throughout the District, indicating that the basin was likely in an overdraft condition.

In 1993, MID entered into a cooperative program with the City of Merced to plan for the region's future water supply. Completed in 1995 and updated in 2001, the Merced Water Supply Plan (MWSP) concluded that, through planned conjunctive management of MID's water resources, the region's future agricultural and Municipal and Industrial (M&I) demands, including selected environmental water demands, could be satisfied. Based on these findings, MID embarked on an aggressive program to restore and expand its conjunctive water management capability. Emphasis was placed on programs and facilities that would increase surface water use within MID by expanding service to lands previously served only by groundwater and by recovering users who, in earlier years, had converted to groundwater supplies.

Further, MID initiated an aggressive in-lieu recharge program based on operational criteria for its conjunctive groundwater wells, and implemented capital improvement projects yielding more than 54,000 AF of groundwater recharge in a normal year. The projects also considered energy reduction and using off-peak power. In addition, MID sold water to growers outside its boundary but within the basin, providing for in-lieu groundwater recharge, as the growers are otherwise solely dependent on groundwater pumping for their water supply needs.

In 2011, MID launched its first "intentional" groundwater recharge project with an estimated yield of more than 15,000 AF annually at full development. The project is operated most aggressively in years of abundant surface water.

Based on these aggressive efforts, there has been a long-term reversal in the trend towards groundwater within MID and more customers are reverting to using surface water supplies when available. The reasons for this positive long-range trend are mostly related to improved level of service through a centralized, flexible water ordering system, flexible water deliveries and modernized and automated infrastructure. However, the most recent severe drought has disrupted this long-term trend.

In addition to the explicit steps taken by MID, other factors influenced the trend including: (a) lower groundwater levels; (b) higher energy cost exacerbated by the lower groundwater table which made MID surface water costs more comparable; (c) lower groundwater quality resulting from a saline water wedge creeping from a saline water sink underneath the SJR into the western areas of the District as a result of lower groundwater levels; (d) a buildup of a salt water profile at the root zone of plants relying on groundwater supplies for their drip and micro spray systems that in many cases significantly impacted crop yields requiring flushing from MID surface water which has minimal salts; and (e) using MID neutral PH balanced water reduced or eliminated the reliance on chemical additives to fight salt build ups in drip and micro spray lines and meeting other fertilizers and pesticides product label requirements.

However, due to the current 2012-2015 drought, MID is concerned that a similar trend towards exclusive groundwater usage may develop. Customers that have always relied on MID surface or groundwater, who had to drill their own private wells during this drought, are unlikely to revert readily to MID surface water. Growers tend to appreciate the independence and ability of a groundwater system in comparison to the logistical and time-lagged issues associated with delivery of surface water supplies. To address this current trend, MID is, in addition to continuing its aggressive conjunctive management activities and actively engaging in all pertinent water management processes and forums, undertaking a long-range capital improvement plan focused on modernization of its facilities to further improve its customer service and meet the changing demands of growers. These changing demands are primarily related to growers continuing sophistication, maximizing production using technology, and conversion to pressure systems. This results in increasing requirement for on-demand deliveries, including time of use and flow rate. Based on these continued and increase efforts by MID, it is anticipated that growers who converted to groundwater pumping systems during the current drought will follow the same decision-making as those that eventually reverted back to surface water during the previous drought for the reasons described above.

1.3 Current Practices

Operations

MID's normal operating objective is to maximize surface water use subject to availability in order to preserve groundwater for use in years when surface supplies are limited. Thus, the proportions of surface water use and groundwater use vary from year to year depending primarily on surface water availability and to some extent on cropping patterns and weather conditions.

The nature of MID's overall conjunctive water management activities can be revealed only through a time series analysis spanning several years and including a variety of hydrologic water year types. For this reason, a key component of this Plan is the District's annual water balance analysis. It provides a unified framework for linking measured inflows and outflows, such as surface water releases and operational discharges, with estimated values, such as deep percolation. This framework allows insightful analysis of the likely effects of implementation of the various Efficient Water Management Practices considered under SB X7-7.

MID utilizes its various water rights and extensive surface and groundwater facilities to optimize the use of water resources within its service area. As discussed, MID's ability to provide a high level of customer service and the ability to meet growers' demands in wet and dry years with its conjunctive management activities has decreased growers' need to install and rely on private groundwater wells. This robust conjunctive management program, combined with competitive water rates, is intended to reduce dependence on groundwater as a primary supply for growers. An extended surface water delivery schedule helps to reduce the demand on groundwater resources in the basin. In addition to meeting the water supply demand during the primary growing season, there are agricultural water supply needs outside of this period. For example, orchard owners often need to secure a post-harvest irrigation as a condition to acquire insurance for their crops. Hence, by providing service later in the year, growers have a lesser need to resort to supplemental groundwater supplies.

Capital Improvement Programs

MID's capital improvement plan is focused on supporting its conjunctive management activities and enhancing water conservation and system efficiency. MID has constructed several smaller reservoirs (i.e., regulating basins), automated certain canals and constructed an extensive Supervisory Control and Data Acquisition (SCADA) network. These projects are used for regulating flows and balancing the supplies and demands of the system. Additionally, MID has improved the conveyance system to better integrate reuse into its operations, leading to increased water conservation and increased conveyance system efficiencies. MID has also completed a number of projects that reduce operational discharges while at the same time improving the service for growers that used to receive flows near the decommissioned spills.

MID is currently completing a new long-range capital improvement plan focused on system modernization. The program includes the construction of approximately 12 new regulating reservoirs, improved water level control along major conveyance systems, increased flow measurement throughout the system, improved control at key locations and new pump-back and intertie projects.

The capital improvement plan is intended to continue to improve service to growers by further increasing the flexibility of water deliveries, improve system efficiency and water conservation, reduce operational difficulties for in-field Distribution System Operators (DSO's), improve control of water deliveries to commitments located outside of District boundaries, and reduce operational discharges from canals.

Integrated Water Management Requirements of MID Facilities

In addition to water supply related functions, MID operations and facilities are used for a variety of integrated water management activities. Certain canals have been designated by MID for raw water supply for future surface water treatment plant(s) at each of the three major cities (Merced, Atwater and Livingston) within MID's designated place of use, as well as certain unincorporated areas.

Based on this designation, only surface water from the Merced River or pumped groundwater from MID's wells are allowed in said designated canals, preserving the sanitary status of the canals, anticipating a shift of urban communities to surface water in the future. This shift is anticipated to occur once the groundwater basin reaches a certain threshold in regards to water quality and groundwater levels that will require the cities to begin using treated surface water for municipal supply. Currently, all cities and communities within Merced County rely on groundwater for all of their water needs.

MID's water conveyance system also includes the use of natural channels for water supply conveyance and distribution. Some of these channels are also used to route storm drainage during the rainy season. These natural channels could also provide relief from flood flows. During the early part of the irrigation season, when surface water is being diverted for supply purposes, the storm drainage and flood control functions are superimposed onto the irrigation function of these facilities. Flood control and storm drainage operations are considered primary functions during this superimposition period, and MID operates them to ensure that its diversions do not impact those functions.

1.4 Foreseeable Actions that May Impact Water Resources Management

MID is a leader in regional water resources management, including conjunctive use, water conservation and system efficiency. As such, it continually strives to improve its management tools and practices and adapt to changing conditions. To further these efforts, MID has embarked on several major initiatives that will also allow it to increase the resolution of various components of future plans. These efforts are briefly described as follows:

- *Enterprise Data Management System (EDMS):* An SQL-based database is the core of this system which interacts and interchanges data between a Geographic Information System (GIS), a water records database, water ordering and billing software, a work order management system, and a facilities inventory application. This is an extensive undertaking that began in 2008 and is expected to be completed by approximately 2017. However, substantial benefits of this effort are realized as each phase of the EDMS is implemented.
- *Water Resources Management Plan:* The plan will assess District assets and provide a long range capital improvement plan focused on system modernization to promote conservation and enhance system efficiency. The plan is expected to be completed by approximately November 2016 and has been driven by a stakeholder-based process that includes MID growers, neighboring water districts and growers, the local farm bureau, as well as local cities and the Merced County.
- *Water Resources Model:* This is a basin-wide, open stakeholder-based process. The model is a work in progress and is expected to provide valuable information to the District's water balance.
- *Operations and Forecasting Model:* MID is also developing an ambitious real-time operations and forecasting model that will use all available assets to optimize the use of available water resources within the MID watershed and local groundwater aquifer. This is a highly sophisticated, long-range effort, but MID staff is making strides in accomplishing this goal and achieving value as each phase is completed.

Regardless of MID's extensive investments and efforts focused on conjunctive use, water conservation, system efficiency and integrated water resources management, MID is very concerned these efforts will be compromised if not completely undermined by the state Water Resources Control Boards ongoing development and future implementation of its Water Quality Control Plan for the Bay Delta, as well as other ongoing regulatory processes.

The State Water Resources Control Board (SWRCB) is currently updating its Sacramento/San Joaquin Bay Delta Water Quality Control Plan. In this update the SWRCB has indicated that they intend to require huge volumes of water be released on an unimpaired flow schedule from MID's primary surface water storage reservoir, Lake McClure. The justification for this large water grab is that it will purportedly benefit delta growers and the delta ecosystem. If the SWRCB continues down this ill-advised path, it will be disastrous for the region. MID's conjunctive management activities are only effective when it is able to effectively balance the surface and groundwater usage. Without reliable, robust surface water supplies, MID would lose the ability to effectively operate conjunctively and may have to refocus its efforts away from conjunctive management towards maximizing surface water diversions when available.

~End of Section ~

Crocker Dam

SECTION 2: PUBLIC PARTICIPATION, REGIONAL COORDINATION (§10826 (d)) AND PLAN ADOPTION AND SUBMITTAL (§10841)

2.1 Public Participation

Public participation in the development of this Plan included:

- Review of the publicly noticed presentation of the draft plan at the Merced Irrigation District Advisory Committee (MIDAC) meeting on November 18, 2015.
- Notification of MID's intent to update its AWMP was made via letters to required agencies on May 13, 2016 and a notice in the Merced Sun Star on June 15, 18, 22, 29 and July 2, 2016.
- Posting of the draft Plan on the District's web page on May 11, 2016;
- Review of the publicly noticed presentation of the draft Plan at a special hearing of the MID Board of Directors on July 5, 2016; and
- Approval of the final Agricultural Water Management Plan at a regularly scheduled Board of Directors meeting on July 5, 2016.

In addition to the specific public outreach activities discussed above, MID maintains a continuous public outreach program via formal and informal processes. For example, the public is invited to attend all Board meetings where time is reserved on each agenda for public comment. The Board members are accessible to the public by phone, e-mail, special appointment and at Board meetings. The District maintains a website where the agendas of all Board meetings are published along with the recent Board minutes, newsletters and other important information. The public can provide comments on District matters via e-mail using a link on the MID website (www.mercedid.org). In addition, the District has a Public and Government Relations Officer who has ongoing communications with interested parties District-wide. The District also distributes a newsletter periodically to publicize important local, state and federal issues impacting its constituents. The District maintains an open exchange of information with local newspapers and, if necessary, issues press releases on matters of importance to the public. The District also relies, to a certain extent, on employees in the field to keep customers informed of the latest water management information.

2.2 Regional Coordination and Previous Water Management Activities (§10826 (d))

MID is a leader in regional water resources management and has been collaborating with regional partners since its inception. This commitment to collaborative water resources planning is evidenced by several major past and current activities, as discussed below. Major activities include:

- Merced Streams Group (late 1930s)
- Merced River Development Project (1960s)
- AB3616 Water Management Plan (WMP), 2002
- Merced Water Supply Plan (1993)
- Castle Dam Flood Control Project (also a regulating basin), 1998
- Vernalis Adaptive Management Plan (1989 to 2011)
- Surface/Groundwater Optimization Program (SUGWOP), 1989 to present
- Merced Area Groundwater Pool Interests (MAGPI), 1997

- Merced Integrated Regional Water Management Plan (2013)
- Surface Water/Groundwater Model for the Merced Basin (Start around September 2013)
- Forecast-Coordinated Operation (FCO)
- Merced Groundwater Basin Sustainable Groundwater Management Act (SGMA)

Merced Streams Group

MID works with the City of Merced and the County of Merced in maintaining the capacity of a portion of creeks identified by the Army Corps of Engineers as necessary for flood protection purposes. These portions generally tend to be portions also used to convey irrigation water. The cooperation has been in existence since at least the 1950s.

Merced River Development Project (1960s)

MID, in cooperation with Pacific Gas and Electric, the Department of Water Resources, the Federal Energy Regulatory Commission, the Bureau of Land Management, the Army Corps of Engineers and the California Department of Fish and Game, as well as MID growers and local land owners, cooperated to design, construct, and set parameters for the new project during the early 1960s.

AB3616 Water Management Plan (WMP)

MID voluntarily prepared a Water Management Plan (WMP) according to the MOU finalized on November 13, 1996 by the advisory committee for AB3616, which established the Agricultural Water Management Council (AWMC). As a signatory of the MOU since 1999, MID documented its performance with the Efficient Water Management Practices established by the Agricultural Water Suppliers as California outlined in the MOU. The WMP was adopted by the MID Board of Directors and submitted to the AWMC. The plan was further reviewed by DWR staff before its adoption by the AWMC. MID demonstrated meeting all required EWMPs per the plan.

Merced Water Supply Plan

In 1993, MID entered into a cooperative program with the City of Merced to plan for the region’s future water supply. Completed in 1995 and updated in 2001, the Merced Water Supply Plan (MWSP) was founded on the conclusion that, through planned conjunctive management of MID’s water resources, the region’s future agricultural and M&I demands, including selected environmental water demands, could be satisfied. Based on these findings, MID embarked on an aggressive program to restore and expand its conjunctive water management capability. Emphasis was placed on programs and facilities that would increase surface water use within MID by expanding service to lands previously served only by groundwater and by winning back users who in earlier years had converted to groundwater supplies.

Castle Dam Flood Control Project (also a regulating basin)

MID, the County of Merced and the Army Corps of Engineers collaborated on a multi-purpose project to provide flood control and a water regulating basin known as Castle Dam. The Castle Dam irrigation pool on Canal Creek was completed around 1998 by the Army Corps of Engineers as a multi-purpose flood control reservoir including an irrigation pool. The pool provides approximately 400 AF of regulating storage and has cut nearly 24 hours off the time required to initiate flow changes at the head of the Livingston Canal.

Vernalis Adaptive Management Plan (VAMP)

Under the San Joaquin River Agreement beginning in 2000, Merced ID and others provided water to help support a scientific study on the San Joaquin River. Part of this program included a pulse flow of up to 110,000 AF of supplemental water for a 31-day period in the San Joaquin River at Vernalis, California, during April and May for ecological resources. The specific amount of the April/May supplemental flow provided each year was determined annually by the Hydrology Group of the San Joaquin River Technical Committee, which included technical representatives from the San Joaquin River Group Authority (SJRGA), US Department of Interior (USDOI), Bureau of Reclamation (BOR) and United States Fish and Wildlife Service (USFWS). The agreement, as amended, expired on December 31, 2011.

Surface/Groundwater Optimization Program (SUGWOP), 1989 to Present

This program started in 1989 and was mainly funded by revenue from the VAMP transfers. Program components were developed independently by MID, but coincide with EWMPs for SB X7-7. The previous WMP addressed SUGWOP in more detail. This program will be replaced by the outcome of the Water Resources Management Plan and guidance from SB X7-7.

Merced Area Groundwater Pool Interests (MAGPI)

MAGPI's mission is to develop technical data and management strategies to improve the health of the Merced Groundwater Basin, which has generally been in overdraft since 1997. Currently chaired by MID, MAGPI members and non-member interest groups include most of the agencies with water supply, water quality and water management authority in the region. MAGPI's vision is to maximize conjunctive water management for reliable local, regional and state-wide water supply and to:

- Expand the in-basin use of surface water
- Expand groundwater production capability
- Continue water conservation efforts
- Monitor groundwater condition with the goal to establish:
    1. A live updatable water budget
    2. Protocols for tracking basin "health"
- Establish a basin Joint Power Authority

In 2008, MAGPI established a subcommittee to encourage cooperative planning among additional aspects of water resources management beyond groundwater management and to lay the groundwork for development of the region's first IRWM Plan. MAGPI completed the Merced Regional Acceptance Process application in April 2009 and subsequently secured a DWR IRWM Planning Grant in February 2012 to develop the first Merced IRWM Plan (MIRWMP). Most relevant to this Plan are technical data documenting the status of the Merced Groundwater Basin which help to support the District's conjunctive use management practices.

Merced Integrated Regional Water Management Plan (2013)

In 2012, MAGPI transferred responsibility for development of the MIRWMP to the interim Regional Water Management Group (RWMG), which is comprised of MID, the County of Merced and the City of Merced. The interim RWMG assembled a Work Plan Management Committee (WPMC), which consists of staff members from each of the interim RWMG agencies. The interim RWMG is responsible for overseeing this first Merced IRWM planning process, and each of its members have committed to continue to support the MIRWMP as a member of the RWMG following adoption of the plan and implementation of the long-term governance structure.

The MIRWMP process has been a stakeholder-driven process. The RWMG is advised by a Regional Advisory Committee (RAC) that represents the broad interests of the Merced Region and shapes the direction of the IRWM program. The RAC was formed in May 2012 following an open application process. All parties that applied for inclusion on the RAC were accepted as either a full member or alternate and officially appointed by the MID Board of Directors, in consultation with member agencies represented by the RWMG. The RAC currently consists of 23 members and 16 alternates representing broad interests and perspectives in the region, including:

- Water Supply Interests
- Wastewater Interests
- Stormwater Interests
- Flood Control Interests
- Local Government
- Agricultural Interests
- Other Business Interests (non-agriculture)
- Environmental Interests
- Other Institutional Interests (e.g. UC Merced)
- Disadvantaged Community and Environmental Justice Interests
- Recreational Interests
- Community/Neighborhood Interests

The RAC has met monthly since May 2012 to discuss regional water management issues and identify regional water management needs, goals and objectives, plans and projects, and future funding and governance. RAC meetings are all publicly noticed and are frequently attended by members of the general public as well as the DWR regional service representative. This broad-based involvement by regional stakeholders has led to balanced input that reflects the wide array of water resources management perspectives throughout the region.

Most relevant to this Plan are technical memorandums completed as part of the IRWMP which support MID's management practices regarding water conservation and conjunctive use, including groundwater recharge.

The plan was adopted by the RAC on June 18, 2013 and the region is currently setting up a JPA for the governance of the plan. MID assumes a leadership role in pursuing grants on behalf of the region under the IRWM Program.

Surface Water/Groundwater Model for the Merced Basin

MAGPI is in process of calibrating a basin-wide water resources model, which is partially funded by DWR. This stakeholder process has been developing for the last two years. The model encompasses Merced Groundwater Basin and extends five miles north of the Merced River, south of Chowchilla River, and West of the San Joaquin River. Results from this exercise will increase the resolution of information MID and other agencies have about the Merced Groundwater Basin. The goal is to utilize the model as a tool to address future planning in the basin and identify best management practices and projects that can be feasibly implemented to increase water supply reliability and meet SGMA goals for the Merced Groundwater Basin and MAGPI areas within the Chowchilla Groundwater Basin.

Forecast-Coordinated Operation (F-CO)

MID is among a handful of water operators, in charge of rim dams in the San Joaquin Valley, along with DWR and Army Corps staff that cooperatively coordinate flood control operations. Watershed models and sensor stations were increased as part of this work. Funding was also provided through DWR to best support various function relation to the F-CO. In addition to its flood control benefit, the District will be able to improve its water supply forecasting and better optimize water resources.

Merced Groundwater Basin Sustainable Groundwater Management Act (SGMA)

The District along with Merced County is leading the effort to coordinate with almost all public water purveyors to facilitate the creation of Groundwater Sustainability Agency/s (GSA) and a Groundwater Sustainability Plan geared towards long term groundwater use sustainability under the SGMA. The group will initially work under a memorandum of understanding that will develop into a more appropriate body best fit for groundwater management by the locals in the Merced Groundwater Basin.

2.3 Plan Adoption and Submittal (§10841)

Upon adoption of the Plan, a copy of the adopted AWMP will be submitted to entities identified below (§10843 (a)&(b)):

- The Department (§10843 (b)(1)) (Electronic copies, preferably in Adobe™ PDF are acceptable)
- Any city, county, or city and county within which the agricultural water supplier extracts or provides water supplies (§10843 (b)(2))
- Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies (§10843 (b)(3))
- Any urban water supplier within which jurisdiction the agricultural water supplier provides water supplies (§10843 (b)(4))
- Any city or county library within the jurisdiction the agricultural water supplier provides water supplies (§10843 (b)(5))
- The California State Library (§10843 (b)(6))
- Any local agency formation commission serving a county within which the agricultural water supplier provides water supplies (§10843 (b)(7))

~End of Section~

Lake Yosemite

SECTION 3. AGRICULTURAL WATER SUPPLIER AND SERVICE AREA (§10826 (a))

This MID Agricultural Water Management Plan has been prepared in accordance with Water Code Section §10826. The following sections are presented in a sequence stated in the Contents of Plans (§10826)

3.1 Size of Service Area (§10826 (a)(1))

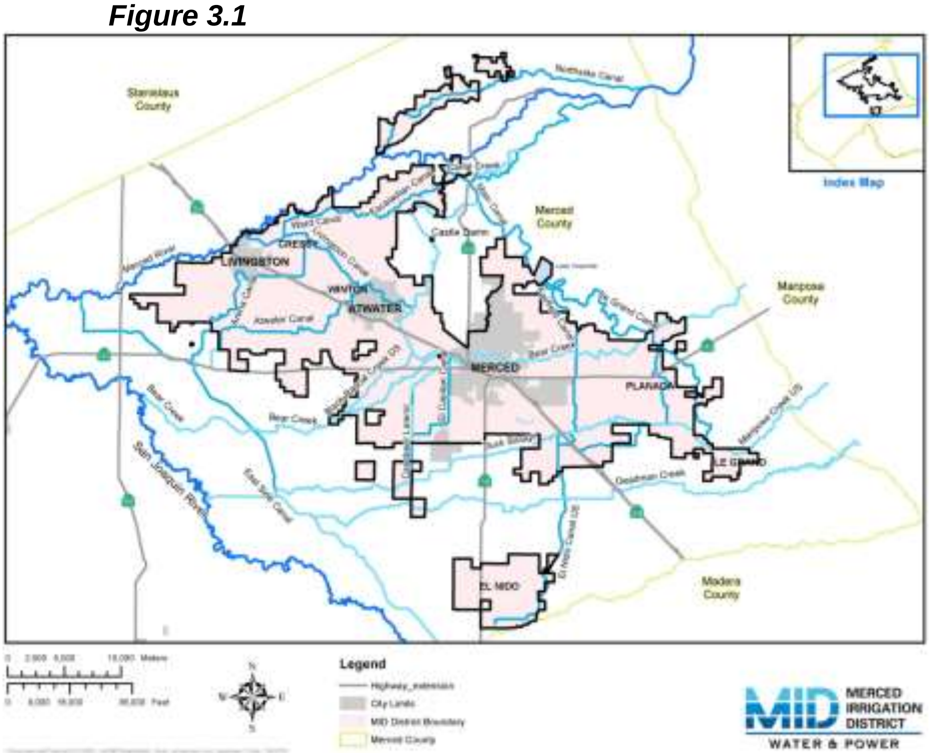
The Merced Irrigation District was formed as an irrigation district under the Irrigation District Law contained in the California Water Code on December 8, 1919. The District covers a service area of 164,317 gross acres, consisting of approximately 132,000 irrigable acres. Of these, approximately 100,000 acres are irrigated partially or totally with surface water (2010-2014)[1]. Eight urban areas, including three incorporated cities, Merced, Atwater and Livingston, are all located within the boundaries of the MID. Table 3.1 provides information on the age and size of the MID, with Figure 3.1 showing a map of the MID's service area.

Table 3.1
Water Supplier History and Size

Date of formation	1919
Source of Water at Time of Formation	Local Surface Water (Merced River/Local Streams)
Present Gross Acreage	164,317
Present Irrigable Acreage	133,000

[1] average irrigated acreage from 2010 through 2014

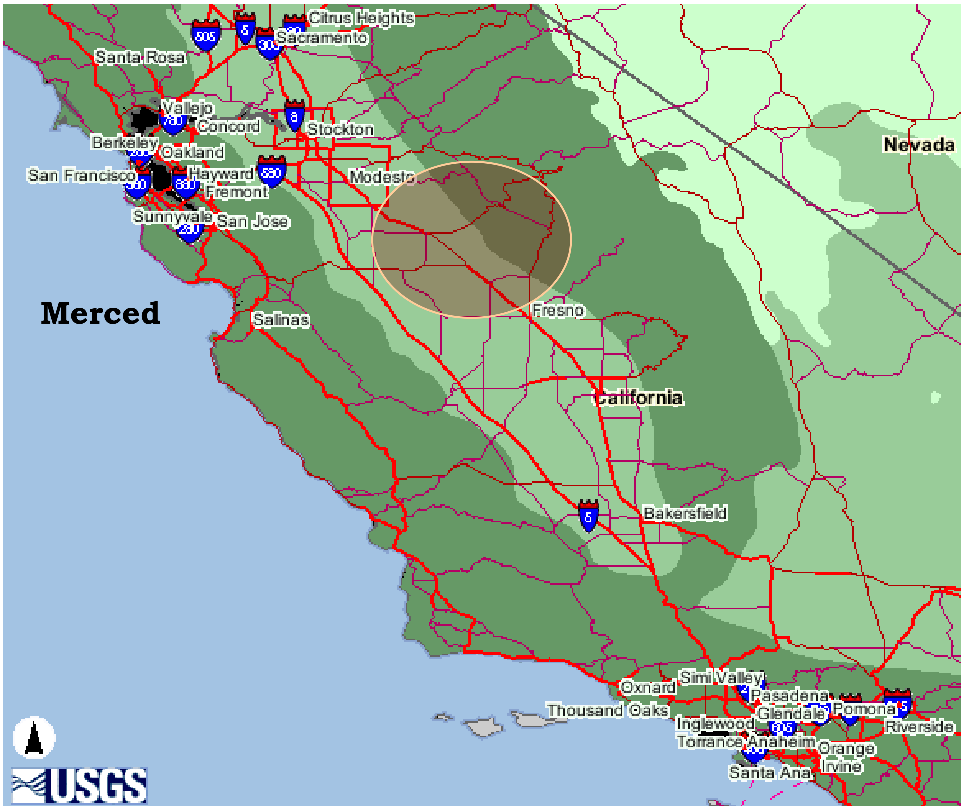
Figure 3.1



3.2 Location of the Service Area and its Water Management Facilities (§10826 (a)(2).)

The MID lies on the eastern side of the San Joaquin Valley in eastern Merced County, approximately 120 miles south of Sacramento and 275 miles north of Los Angeles as shown in Figure 3.2.

Figure 3.2



The Merced River provides the principal surface water supply for the District and other areas overlaying the Merced Groundwater Basin. With respect to the District, water is diverted from the Merced River at two locations: the Northside Canal diversion and the Main Canal diversion. The Northside Canal diversion pool is created by Merced Falls Dam, and the Main Canal diversion pool is created by the Crocker-Huffman Diversion Dam, a reinforced concrete structure originally completed in 1870. The earliest diversion into the Main Canal was in 1857. The Merced Falls Dam was originally constructed in 1873 to divert Merced River waters.

Lake McClure, the District's principal water storage reservoir, is impounded by New Exchequer Dam, which is owned and operated by MID. New Exchequer Dam was completed in 1967, replacing the original dam, completed in 1926, which was located downstream from the original wood crib-type dam constructed by the Exchequer Mining Company in the 1800s. Lake McClure's capacity was expanded from 270,000 AF to 1,024,600 AF once New Exchequer Dam was completed.

The MID distribution system includes approximately 851 miles of conveyance facilities. See Table 3.2 for details.

MID's system was originally designed as a "flow-through" system, meaning that a substantial fraction of carriage water was diverted and routed through the system along with water for delivery to users. The extra water allowed users and operators to "turn on" and "turn off," within certain limits, with limited advance notice, thereby providing a high degree of operational flexibility. As the District modernizes its infrastructure, its capital improvement plans/activities have been focused, among other things, on maintaining this high level of service while improving the distribution system to reduce flow-through losses.

The MID distribution system includes portions of natural streams and drains that convey irrigation water during the irrigation season and flood flows during the off season. These reaches collect and enable reuse of canal operational discharges and return flows during the irrigation season.

The District also owns approximately 215 groundwater wells. Table 3.2 provides information on District wells and conveyance facilities.

Table 3.2
Water Conveyance and Delivery System

System Used	Number of Miles
Unlined canal	399
Natural Channels (creeks and sloughs)	132
Lined canal	107
Pipelines	181
Drains	32
Total Mileage of System	**851**
Active Wells	215
Delivery Gates	2547

The District possesses several smaller reservoirs that are used for regulating flows and balancing water supply with demand (see Table 3.3). Lake McSwain is located on the Merced River and serves to re-regulate flow releases from Lake McClure and to help to ensure steady instream releases. Lake Yosemite, completed in 1888, is located north of Merced, along the Main Canal, and originally served as a forebay for piped surface water deliveries to the City of Merced utilizing the Main Canal, also completed in 1888. Those deliveries were discontinued in 1927, but the lake continues to serve as a Main Canal regulating reservoir and a popular recreational area for residents in Merced.

Bear Creek Pool is formed by Crocker Dam, which was originally constructed as a wood-crib dam in the late 1800s. It was later replaced by a reinforced concrete dam that captures runoff from the entire Bear Creek watershed, including Parkinson Creek, Fahrens Creek, Cottonwood Creek, Black Rascal Creek, Bear Creek, and Burns Creek. It was originally constructed as a direct diversion facility, with limited regulating capacity, but recent improvements have created approximately 223 AF of additional regulating storage.

Castle Dam on Canal Creek was completed around 1998 by the Army Corps of Engineers as a multi-purpose flood control reservoir including an irrigation pool. The pool provides approximately 570 AF of regulating storage and has cut nearly 24 hours off the time required to initiate flow changes at the head of the Livingston Canal, located five miles downstream from Castle Dam. Mariposa Creek Pool and El Nido Reservoir were similarly improved creating up to nearly 70 and 200 AF of regulating capacity, respectively. The latest addition to MID's regulating capacity is Livingston Automatic No. 2, which was completed in 2005. It is MID's only off-canal basin which can be completely bypassed without impacting operations.

Following in Table 3.3 is a summary of all the regulating pools in the system.

Table 3.3
Regulating Reservoirs

Regulating Basins	Completed After 2002	Total Volume (AF)	Active Regulating Volume (AF)
Lake McSwain		9,740	1,600
Lake Yosemite		8,201	1,000
Castle Dam Irrigation Pool		570	400
Bear Creek Pool (Crocker Dam)		223	180
El Nido Reservoir	√	196	180
Livingston Automatic No. 2	√	95	90
Mariposa Creek Pool (El Nido Dam)		66	60
Puglizevich Dam Pool		29	25
Livingston Canal Pool		20	20

Table 3.4 describes tailwater and operational discharge recovery mechanisms now in place within the District.

Table 3.4
Tailwater/Operational Discharge Recovery System

System	Description
District-Operated Tailwater/ Operational Discharge Recovery	Most operational discharges are recaptured in creeks or interceptor canals where they are reused either within MID or downstream.
Grower-Operated Tailwater/ Operational Discharge Recovery	Since the 1980s the District has had a moratorium on drainage discharge to canals. While a number of drains are grandfathered, the District is working to minimize the number of drains discharging into canals. Most of the farmers in the western portion of MID have no offsite drainage. Some farms in the eastern portion drain to natural sloughs.

MID charges volumetrically at the farm turnout, meeting SB X7-7 requirements. MID strives to provide its growers with as much flexibility as possible with regard to frequency, rate and duration of irrigation events.

MID uses different water ordering and delivery schedules (see Table 3.5), depending primarily on the operational capabilities of portions of the distribution system. Most users are provided water under an Arranged Demand system, where the user places an order with the District and water is delivered later, typically within two to three days. In the last few years, the majority of orders have been filled within 24 hours. Where requested and determined to be practical, the District offers "on-demand" service, so that the water user can turn on and off, without advance notice to the District. This is typically provided to drip and micro-spray users whose systems are equipped with cumulative volumetric meters, which draw directly from a main canal or from large laterals where the fluctuations in canal flow resulting from "on-demand" service can be re-regulated downstream. Depending on available water supplies, MID may mandate rotation on laterals with limited capacity to ensure sufficient supplies to all users.

Table 3.5
Supplier Delivery System

Type	Mark if Used
On demand	X
Arranged demand	X
Rotation	X
Other	X

MID strives to provide flexible water ordering capabilities for growers. An irrigation customer can call the office, send a fax during the working hours, use an Automated Voice Recognition System or the Web to place their delivery orders. The water account may be accessed through a Web connection and it can also provide history of deliveries and invoices. Since 2008, MID Distribution System Operators (DSOs) have been equipped with laptops that receive the water orders from MID headquarters over a wireless network into a water order software that keeps track of delivery orders. The DSOs also use a Supervisory Control and Data Acquisition (SCADA) system to monitor and manage water in their area with help from the Senior Distribution System Operators (SDSOs), who is in charge of a larger distribution area and the reservoirs serving their distribution area.

Table 3.6 lists agencies with whom MID coordinates in carrying out its operations and the nature of the restrictions that this coordination now imposes. It should be noted that some of these restrictions could place a significant challenge on irrigation operations.

Table 3.6
Restrictions on Water Sources

Restrictions	Name of Agency Imposing Restrictions	Operational Constraints
Flood Control Space	U.S. Army Corps of Engineers	None
Minimum Reservoir Pool	FERC	Must use groundwater pumping
Power Generation Forecasting	State Independent System Operator (Cal ISO)	Limits flexibility as diversion forecasts are set in advance
In-Stream Flow	FERC	Loss of water supply to satisfy in-stream flows
In-Stream Flow (Nov-Mar)	DWR (Davis-Grunsky)	
In-Stream Pulse Flow (October)	SWRCB	

Since the early 1930s, MID has provided supplemental water to lands within the former El Nido Irrigation District (ENID), when surface water supplies were adequate, utilizing the District's pre-1914 water rights. In 2005, the former ENID's 9,923 acres was consolidated into the MID service area. Lands within the former ENID service area were classified as MID Class II users, receiving 50-percent of the surface water supply made available to Class I users, on an acre-feet per acre basis. As a result of the consolidation, MID storage and direct diversion licenses were amended to include a 12,500 AF pulse flow for fish attraction and spawning flows for fall run Chinook Salmon during the month of October. Since the ENID consolidation, there have been no other consolidations or annexations to the MID service area. Table 3.7 notes factors that may affect the size of the MID service area.

Table 3.7
Changes to the Service Area

Change to Service Area	Effect on the Water Supplier
Increased service area size due to consolidation with El Nido Irrigation District and simultaneous urbanization within the existing boundaries of MID	12,500 AF additional release to Merced River in October

3.3 Terrain and Soils (§10826 (a)(3))

The irrigated land in MID is typically mildly sloped with a fall of about one foot per 1,000 feet. Most fields that are surface irrigated employ laser leveling to achieve and maintain uniform grades. Pressurized systems are used in undulating areas that are not suited to land leveling, and, increasingly, as replacements for, or in conjunction with, surface irrigation systems on permanent crops.

The soils in the eastern part of MID are typically medium- to fine-textured, with the majority of fields using surface irrigation systems that generate little tailwater. Pastureland in MID tends to be located on slightly steeper ground, and there has been a gradual substitution of permanent crops (trees and vines) for crops such as pasture over the last thirty years or so. Soils in the western portion of the District are typically medium-to-coarse textured, with most having medium to rapid intake rates.

The spatial variation in soils from east to west has resulted in the majority of the orchard crops being located in the western portion of the District while the row crops still thrive in the eastern portion. Water conserving irrigation measures, such as micro sprinkler and drip systems, are concentrated in the western portion of the District, the area MID has traditionally relied on for groundwater extractions in years of surface water shortages.

Table 3.8 describes the influence of local topography on District operations.

Table 3.8 Topographic Impacts	
Topography Characteristic	**Impact on Water Operations**
Natural streams and sloughs	Mostly located in the eastern portion of the District. Integrated into MID's water delivery and drainage system. Natural channels that are used as conveyances in their upstream reaches may serve as drains downstream of the delivery service area. Natural channels also convey stormwater during the non-irrigation season. Most creeks and sloughs are located in the eastern portion of the District.
Land slope	Does not constrain irrigation operations.

Table 3.9 describes the effects of local soils on District operations.

Table 3.9 Soil Characteristic Impacts	
Soil Characteristic	**Impact on Water Operations**
Eastern portion: typically clay based to loamy soils	Limited groundwater recharge; basin-check irrigation generates little tailwater.
Western portion: typically loamy to sandy soils	Moderate recharge rates make this area important to MID's conjunctive management approach.

3.4 Climate (§10826 (a)(4))

The average annual precipitation within the District's service area is approximately 12 inches, coming primarily between November and March. In most years, this rainfall is sufficient to meet the water needs of winter annuals, pasture and winter cover crops in the orchards. There are generally no irrigation deliveries during this period unless a continuous dry period creates needed demand such as the case with the winter of 2000. The District opted to make a two-week surface water deliveries during a normally off-irrigation season period.

During the off-season (November through mid-March), MID occasionally makes its deep groundwater wells available for frost protection purposes. Surface water may also be used. Growers purchase flows at the MID well and incur all losses between the well and their delivery gates during this period.

Table 3.10 Climate Characteristics	
Climate Characteristic	**Value**
Average Annual Precipitation	12.29 inches
Minimum Mean Monthly Temperature	35.5 ºF (December)
Maximum Mean Monthly Temperature	96.7 ºF (July)

The characteristics of microclimates within the District do not range widely and, therefore, have little impact on District operations or on-farm water requirements. Table 3.10 describes some characteristics of the local climate.

3.5 Operating Rules and Regulations (§10826 (a)(5))

A copy of the Merced Irrigation District Rules and Regulations Governing Distribution of Water is included in Appendix A. These rules, updated occasionally at the direction of the Board, describe procedures for water ordering and operation of the MID water distribution system. It is expected that an updated set of rules will be adopted as a result of the nearly completed MID Water Resources Management Plan, a long-term plan described above.

3.6 Water Delivery Measurements or Calculations (§10826 (a)(6))

The following describes the frequency with which MID makes measurements, calibrates water measurement devices and performs scheduled maintenance on these devices. Also included below is an assessment of the estimated accuracies of the various measurement devices. See Appendix F, Water Measurement Documentation and Reporting for a more detailed discussion regarding the Agricultural Water Measurement Regulation.

There are various infrastructure and operational components that impact measurement at the turnout. Major components include on farm irrigation systems, turnout types and measurement configurations, each discussed in more detail below.

On Farm Irrigation Systems

On farm irrigation systems can be generally classified into three major categories:

1. Open Flow systems (gravity)
2. Pressurized Systems
3. Integrated Systems

Open flow systems are typically associated with flood or furrow irrigation methods, while pressurized systems are typically associated with sprinkler systems, mircomist systems, drip, impact sprinklers, etc.

Integrated systems are designed to serve one field, but have piping or ditch connections that can convey MID water supplies to other fields.

MID's Existing Turnout Configurations

Generally speaking, there are five primary types of turnouts at MID:

1. Upright structures
2. Canal gates on headwalls
3. Slant structures
4. Concrete boxes on pipelines
5. Other turnout configurations including:
    a. Concrete standpipes on pipelines

b. Booster Pump or Groundwater Well Systems: These systems typically discharge to a pipeline that then serves one or more growers by connecting to the growers' pipelines, standpipe or boxes.

c. Pressure Boxes: Concrete boxes with a poured-in-place top (i.e., not open top concrete box).

d. Alfalfa valves on an MID pipelines

e. Inline valves

f. Other non-standard configurations

Flow through each primary type of turnout is typically controlled with a canal gate (such as a standard Fresno Valve C101 gate), while delivery flows through booster pump and groundwater well systems are dependent on the specific installation configuration and include canal gates, gate valves, butterfly valves and other methods.

Existing Flow Rate Measurement Configurations

There are two primary measurement configurations within MID, metered turnouts and meter-gate turnouts.

Metered Turnouts

Flows to fields measured with a meter, such as the McCrometer Propeller Meter or other MID approved, factory calibrated meter, can be associated with any of the aforementioned turnout configurations. MID staff regularly read existing meters, typically once per week, to determine the volume of water for billing purposes. In practice, the DSO enters the current meter read into the operations database, which subtracts the previous meter read and calculates AF for billing purposes. Metered installations are typically serving Pressurized Irrigation Systems, although a few Open Flow Systems have installed meters.

Turnouts are checked daily and cleared of debris as necessary when in use. MID-approved meters are calibrated from the factory. The flows through the meters are periodically verified to conform to expected flows using an ultrasonic test meter. When necessary, the meter undergoes maintenance and is factory re-calibrated as required. The accuracy of the propeller meters, the most common meter in use, is ±2 percent as specified by the manufacturer if properly installed and maintained.

Meter-Gate Turnouts

Flow rates through meter-gate structures are measured with a canal gate. Canal gates, such as a standard Fresno Valve C101 gate, installed vertically and including a downstream measuring vent, provide instantaneous flow readings based on a manufacturer specific rating table and the differential head across the gate and the gate opening. These configurations typically serve Open Flow Systems, although some Pressurized Irrigation Systems are measured using this method. Measuring with a canal gate consists of taking measurements of the head differential across the gate and the gate opening. These readings are compared to a rating table from the gate manufacturer, which correlates to an instantaneous flow rate. The instantaneous flows are then multiplied by the duration of the irrigation event to determine the volumetric total which is used for billing. This method is used for upright structures, canal gates on headwalls, and deliveries from concrete boxes and standpipes.

Slant structures typically serve Open Flow Systems, although some Pressurized Irrigation Systems are served by slant gates with a meter-gate. Flow rates through slant structure meter-gates are estimated from a combination of available tools, such as measuring flow in grower ditches, crop-soil science relationships and estimated ETc values, measuring the flow upstream and downstream of the turnout, estimating flows based on the specifications and quantity of sprinkler heads or other distribution devices, etc.

Other

Flow rate measurement techniques are similar to those used for other meter-gate measurement structures, depending on the turnout details and the grower's on-farm irrigation system.

Meter-gate measurement configurations are typically measured once during an irrigation and as needed depending on changing conditions. The DSO enters the instantaneous flow rate, start time and end time, as well as the time and value of any flow changes, into the operations database, which performs the acre-foot calculation for billing purposes.

The turnout is checked daily and cleared of debris as necessary when in use. Annual maintenance consists of checking that zero gate marks have not changed due to wear of valve stem threads or the face of the gate. Gates are repaired and calibrated when wear indicates it is necessary. The margin of error is estimated to be approximately 15 percent.

3.7 Water Rate Schedules and Billing (§10826 (a)(7))

MID adopted a volumetric rate for its water sales in 1993. MID sells water by the acre-foot, in increments of 0.1 AF. By this long-standing adoption, MID meets SB X7-7 requirements.

MID's rate structure includes a $24 per acre standby charge assessed against the gross acreage of all irrigable land regardless of MID water deliveries. In addition to the standby charge, accounts are charged a volumetric rate for delivered water supplies. The Board sets a rate up to a maximum of $100.67 per acre foot for surface water deliveries and prices for the voluntary conjunctive supplemental water supply pool program annually, taking into account, among other things, the District's financial needs as well as its conjunctive management strategies at the time, all representing MID's cost of providing service.

MID's standby fee has remained at $24.00 per acre since 1994. Table 3.11 shows MID's volumetric billing structure over the last several years.

Table 3.11
Volumetric Billing Structure

Year[1]	Surface Water Rate ($/Acre-Foot)[1]	Conjunctive Supplemental Water Supply Pool Program[3] ($/Acre-Foot)	Municipal and Industrial (M&I) ($/Acre-Foot)
2010	$18.25	NA	$125.00
2011	$18.25	NA	$125.00
2012	$18.25	NA	$125.00
2013	$23.25	$73.25	$125.00
2014	$75.00	$110.00	$125.00
2015	$100.00[4]	$225	$225.00

1. MID converted from a calendar year budget to a fiscal year budget (April 1 to March 28) in 2013. Therefore, years 2010 to 2012 are calendar years. Years after 2012 are fiscal years.

2. The voluntary conjunctive supplemental water supply program was implemented in 2013. Prices shown prior to this reflect cost of service, total water deliveries, including conjunctive supplemented water supplies.

3. Due to the ongoing drought, MID did not allocate surface water supplies during 2015. There was a small, emergency surface water diversion in July. Surface water supplies during this short irrigation run were charged at $100.00/AF.

Water customers are billed monthly for water deliveries. Garden Heads is the term used for small homesteads less than 5 acres. Most Garden Head users do not grow crops for commercial benefit. In the past, they paid a flat fee, assuming usage of 3 acre-feet/acre and did not need to place a water order for each irrigation. Beginning in 2012, Garden Heads have been required to place water orders and are charged volumetrically.

MID is currently developing a long range business plan that may result in alternative billing structures. This plan, known as MID's Water Resources Management Plan will determine costs necessary to meet the District's long-range operations and maintenance needs as well as costs required to further modernize and improve its water conveyance and distribution facilities. Based on these costs, the District will consider a range of financial options that meet these needs while facilitating its various policy goals, such as robust conjunctive management.

3.8 Water Shortage Allocation Policies (§10826 (a)(8))

For more information, please refer to Appendix C, Merced Irrigation District Drought Management Plan, attached.

The District is located in an area that cannot purchase water from other entities so MID must rely on its available local resources, both surface and groundwater resources. This fact is one of the drivers for MID's conjunctive management practices and why MID's drought water management approach is encompassed by the broader practices dealing with conjunctive water management. MID's conjunctive water management strategy is intended to facilitate sustainable groundwater management by striving to ensure that groundwater conditions will be such that that supplies available to MID users in times of drought will be sufficient to meet their needs. However, conjunctive management practices rely on a robust and dependable surface water supply. Due to the ongoing drought, even growers who have traditionally relied totally on surface water are constructing private groundwater wells.

The District's Board of Directors annually determines available surface water supplies on an acre-foot/acre basis for Class I and Class II water users. The Board also determines estimated required conjunctive groundwater pumping above the base pumping requirements. Staff develops recommendations to the Board based on forecasted runoff, in-stream flow requirements, historical water commitments (e.g. senior water right holders or adjudicated rights), estimated system losses, and desired carryover storage in Lake McClure.

The Board also annually adopts a Water Management Implementation Plan (WMIP) that sets the rules for the irrigation season based on its current policies and hydrological conditions. This approach allows the Board to set water delivery rules on an adaptive management basis depending on current conditions. For example, the WMIP sets rules for water reallocation amongst growers and rules regarding private water wheeling in MID facilities. When surface water supplies are ample, reallocations and private water wheeling are restricted due to capacity limitations within the MID conveyance system. During years of water shortage, flexibility is increased allowing growers to work with the District and amongst themselves to survive the season. WMIPs from 2013, 2014 and 2015 are attached for reference.

3.9 Policies Addressing Wasteful Use of Agricultural Water

MID Rules and Regulation for the Distribution of Water addresses issues of wasteful water, see Appendix A.

~End of Section~

Lake McClure
(Full Lake)

Lake McClure
(historic lows)

SECTION 4. INVENTORY OF WATER SUPPLIES (§10826 (b))

This section of the Water Management Plan describes the quality and quantity of water available to the MID from surface and groundwater sources. The section continues by describing water usage within the MID service area.

4.1 Surface Water Supply (§10826 (b)(1))

The District's surface water supply is made of the following components:

- *Merced River:* The Merced River is the main source of MID's surface water supply. The District diverts direct flows and stored water impounded in Lake McClure by New Exchequer Dam on the Merced River. MID holds Pre-1914 direct diversion rights on the Merced River that dates to 1857. The Districts also owns historic pre-1914 reservoirs, currently inundated by New Exchequer Reservoir.
- *Merced Streams:* The District also receives natural flows from Merced Streams. These are creeks that originate in watersheds of the lower elevation slope (peak elevations around 4,600 feet MSL). Merced Streams are generally identified as all natural streams between Merced River to the north and Chowchilla River to the South. The major creeks are Canal Creek, Edendale Creek, Parkinson Creek, Fahrens Creek, Cottonwood Creek, Burns Creek, Bear Creek, Miles Creek, Owens Creek, Mariposa Creek, and Deadman Creek. The District's surface water conveyance system utilizes portions of each of these streams. Except for creeks intercepted by Lake Yosemite, the District can only make direct diversion flows when flows are present and as restricted by a license, as applicable. MID maintains pre-1914 rights on a number of these creeks, such as creeks that drain to Crocker Dam, a 223 AF pool on Bear Creek west of the city of Merced that intercepts drainage from 283,346 Acres of water sheds spanning from Canal Creek to the north to Bear Creek in the south. MID holds Post 1914 licenses on other creeks such as Mariposa/Duck Slough and Deadman Creeks.
- *Lake Yosemite:* Lake Yosemite is a small reservoir in the foothills northeast of the city of Merced. Capacity of the lake is approximately 8,000 AF and was completed in 1888. The lake receives diversions from the Merced River, and intercepts flows from Canal Creek, Edendale Creek, Parkinson Creek and Fahrens Creek, in addition to the Lake Yosemite local watershed. The lake is subject to flood control restrictions which typically require reduction of storage to 4,000 AF during the winter months. MID holds pre-1914 water rights on this reservoir.
- *Lake McClure:* The District diverts water from Lake McClure, according to a series of post-1914 water rights licenses for flow and storage recognized by the State of California. The lake has a maximum holding capacity of 1,024,000 AF. In addition, the Army Corps of Engineers Water Control Manual for Lake McClure requires that the District reserve 350,000 AF of reservoir capacity for rain flood control purposes. This reserve must be maintained from November 1 through March 15. An additional 50,000 AF may be vacated, beginning March 1 for forecasted snowmelt runoff.

4.2 Restrictions on Surface Water Supply:

The restrictions on MID's surface water supplies are:

Natural Restrictions:	Hydrology, timing of runoff versus demand
Logistical Restrictions:	Reservoir capacity, flood control limitations

Natural Restrictions: Natural restrictions associated with the Lake McClure watershed are primarily associated with hydrology. Multiple dry years severely limit MID's water supply and impact all of its beneficial uses. The Merced Streams' watershed is mainly a rain-driven drainage basin. In above average water years, the Merced Streams may generate significant flows as a result of rain events. Since there is little to no storage on these streams, including Lake Yosemite during flood control restrictions, flows can only be diverted if there is an agricultural demand. The demand flows are typically significantly less than the supply, especially in wet years. MID continues to make opportune diversions in years where runoff coincides with demand during the early part of the irrigation season.

Logistical Restrictions: A number of MID Assets are subject to various water rights and flood control rules set by State or Federal agencies:

New Exchequer Reservoir

Flood Control:

The reservoir is subject to rules listed in its 1981 Flood Control Manual where the reservoir would be held at 674,000 AF or less between November 1 and March 15 (Very). Storage can be increased after March 15 to reach the maximum storage capacity of 1,024,000 AF, which can be reached by July 1st. By August 1st storage starts its decent to total flood control capacity by November 1st.

Water Right Rules:

MID cannot store flows after July 1st which makes maintaining maximum storage challenging.

Lake Yosemite

Flood Control Restrictions:

Lake Yosemite is vacated to 4,000 AF storage during the winter months, which limits the lake's ability to store runoff in the winter months.

The Main Canal

Flood Control:

Almost the entire upstream half of the Main Canal, the section between the Merced River and Edendale Creek, is burdened by flood constrictions as part of the Castle Dam flood control project.

Crocker Dam:

Crocker Dam is a removable dam that checks flows in Bear Creek. MID removes the dam during the flood season for flood operations purposes. The manual operation of the dam limits diversions when the storm season overlaps with the irrigation season.

Other Dams on Merced Streams:

These sites, including Puglizevich Dam, Miles Creek Dam, Monnett Dam and el Nido Dam, face the challenge as Crocker Dam.

Le Grand Canal at Black Rascal Creek:

The Le Grand Canal is one of two canals that make up the major outlets from Lake Yosemite. Le Grand Canal traverses along the toe of the western Sierra foothills and continues to the town of Le Grand for a distance of more than 16 miles. However, the Le Grand Canal is physically severed during the flood season, conveying flood flows to Black Rascal Creek, a Creek tributary to Bear Creek. This manual operation severely restricts the ability to convey storm flows from Lake Yosemite to the south eastern areas of the District for recharge during the flood season.

The above is not a comprehensive list but is intended to include major restrictions impacting MID's surface water supplies.

4.3 Groundwater Supply (§10826 (b)(2))

MID's service area overlays a portion of the Merced Groundwater Basin, as well as small portions of the Turlock and Chowchilla Groundwater Basins. MID participated in preparation of the local AB 3030 Regional Groundwater Management Plan completed in December, 1997. In July 2008, MID, along with other members of MAGPI, prepared an update of the Merced Groundwater Management Plan, which included components of the 2002 legislation of SB 1938 and SB 1672. This updated plan is included as Appendix E. Groundwater conditions and recharge are further addressed in the Merced IRWMP.

Table 4.2 contains information on the groundwater basins underlying MID. This information was taken from the DWR Bulletin 118-2003 description of the Merced Groundwater Basin. The storage estimate is based on data collected in 1995 by DWR.

Table 4.2
Groundwater Basin Underlying District

Groundwater Basin Name	District Footprint (acres)	Basin Area (Sq. Mi.)	Total Capacity (300 feet depth) (AF)	Specific Yield
Merced	149,500	767	15,700,000	9 percent
Turlock	5,500	542	12,800,000	10.1 percent
Chowchilla	9,000	248	5,500,000	8.6 percent

Table 4.3 describes the destinations of deep percolation from MID lands.

Table 4.3
Deep Percolation Characteristics

Destination	Volume (AF)
Flows to saline sink	Not Quantified
Unrecoverable flows to perched water table	None

Historically, the area experienced problems with a high water table, including standing water in many locations, which proved detrimental to agriculture and urban development. This occurred primarily in the areas south and west of the city of Merced. In the 1920's, among many other actions, MID delineated various drainage area for planning purposes and installed numerous piezometers to track perched water tables. These piezometers, known as Section Corner Test Wells, were generally installed at strategically located corner sections to track the depth of the perched water table. Section Corner Test Wells are usually 2-inch in diameter and extended no more than 20 feet below grade. Figure 4.1 following shows the current locations of MID's Section Corner Test Wells. Historically measured monthly, MID reduced measurements occurrences to twice a year as the perched water levels receded over the years.

Natural groundwater flow in the Merced Groundwater Basin is generally from northeast to southwest. However, cones of depression caused by pumping and groundwater mounds resulting from irrigation complicate the general flow pattern, causing the pattern to change over time. The response of the aquifers to changes in pumping and irrigation is relatively rapid leading to equally rapid shifts in flow direction.

Figure 4.1, Current Location of MID's Corner Section Wells

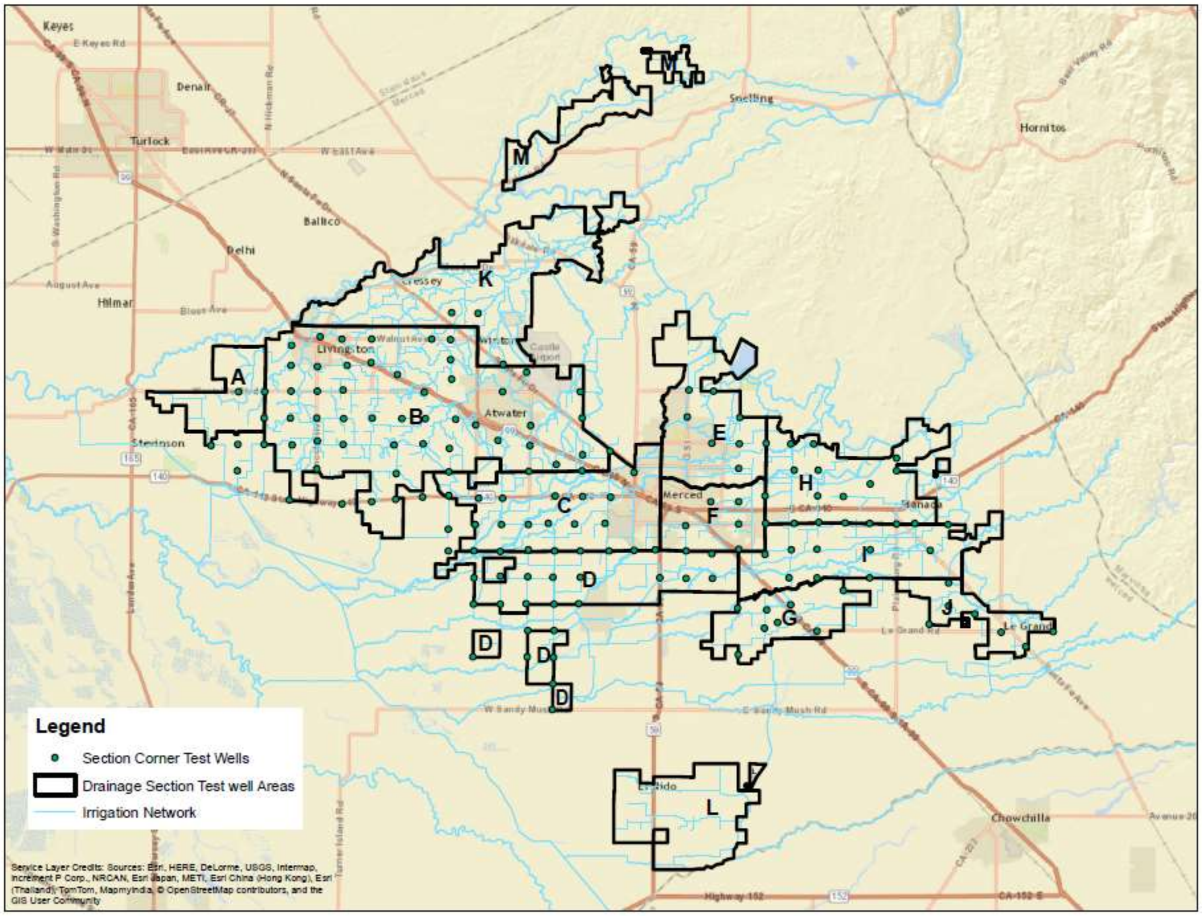
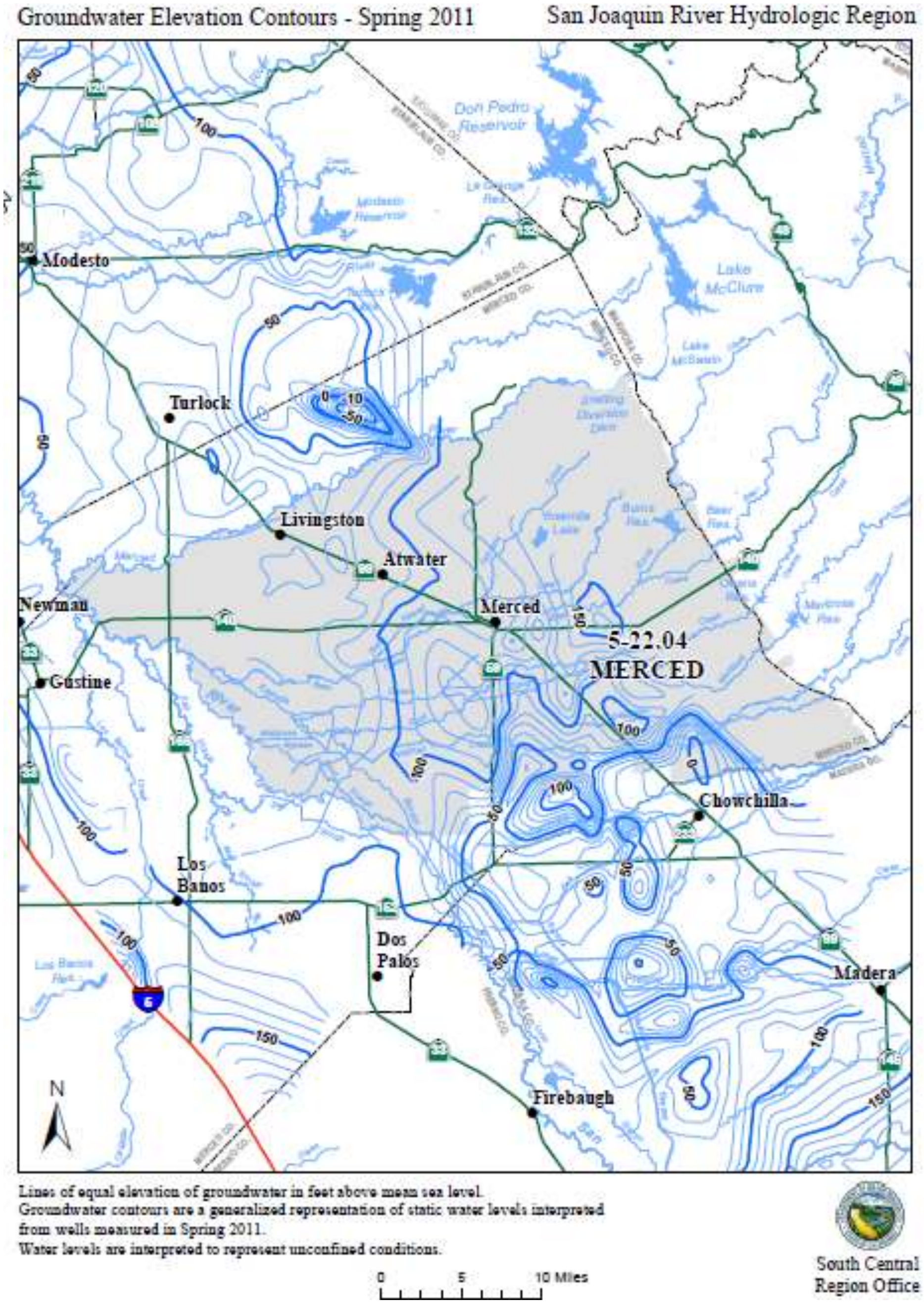


Figure 4.2, on the following page, depicts a map with groundwater contours generated by DWR. This map indicates several major cones of depression further pronounced between 1995 and 2010. One cone is centered approximately 13 miles southeast of Merced in the Le Grand/Athlone Water District. A second major cone is centered about 13 miles southwest of Merced just north of the San Joaquin River. The third major cone is 17 miles northwest of the City of Merced and lies north of the District in the Turlock Groundwater Basin.

Figure 4.2, Groundwater Elevation Contours – Spring 2011



The groundwater elevations relative to the elevations of the major rivers and the interaction of cones of depression with the rivers suggest that some reaches of the rivers lose water to groundwater while others gain from groundwater discharge.

The groundwater elevation data appears to indicate that there is a trough in the water table elevations that follows the San Joaquin River. Consequently, groundwater inflow to the river and surrounding areas occurs from both sides of the San Joaquin Valley. This river and the surrounding areas are the primary groundwater discharge areas for the valley. There is also an extended cone of depression straddling the Chowchilla River west of the San Joaquin River. The cone of depression seems to have further developed subsidence in the Red Top area.

On the north side of the District, west of Highway 99, the lower reaches of the Merced River appear to be a groundwater discharge area. East of the Highway 99, the river may be acting as a constant head source and supplying water to a large cone of depression centered approximately 17 miles northwest of Merced. East of Oakdale Road, the river is higher than the groundwater and probably provides some recharge to the groundwater.

The vertical groundwater gradient, and hence the direction of vertical groundwater movement, is downwards, from the shallowest groundwater to the deeper aquifers. Consequently, degradation of shallow groundwater can potentially affect deeper water supply wells where this downward movement is significant and dilution and chemical/biological processes are insufficient to adequately reduce the concentrations of constituents of concern.

As described above, the direction of the groundwater flow, except in the vicinity of the Merced River, is from northeast to southwest on a line generally perpendicular to the San Joaquin River where a natural saline water sink occurs. Deep percolated water not extracted by groundwater wells tend to end at the sink. However, deep percolation around the District’s southwesterly boundary is required to stem the saline water wedge from migrating to the east, where the primary agricultural grounds in the District and urban centers tend to concentrate.

4.4 Groundwater Demand

As previously discussed, the majority of the MID service area overlies a portion of the Merced Groundwater Basin. Although overlying small portions of the Turlock and Chowchilla Groundwater Basins, MID does not have any conjunctive groundwater wells within these basins and makes no groundwater extraction from either Turlock or Chowchilla Groundwater Basin. MID growers may have private wells within the District overlying these basins and would utilize them as necessary.

Agricultural groundwater demand in the MID service area includes MID’s conjunctive management operations and private groundwater pumping.

A. Currently, MID has approximately 215 conjunctive groundwater wells overlying the Merced Groundwater Basin and conjunctively manages its surface water supplies with available groundwater supplies. MID’s groundwater operations include its baseline pumping operations and its conjunctive groundwater pumping, each further discussed below.

   1. *Base Line Groundwater Pumping*: The District service area contains 1,764 acres of high grounds that cannot receive gravity water deliveries. These areas are served with groundwater wells and deliveries to these areas are considered baseline pumping. Baseline pumping also includes conjunctive groundwater supplies provided after the irrigation season for purposes such as frost protection. Baseline groundwater pumping occurs in all water year types. Historically, MID’s baseline pumping averaged 8,000 AF annually. As part of its conjunctive management activities, MID has been installing booster pumps and constructing other related projects at key locations to serve the high grounds with surface water. Due to these efforts, MID reached a record low baseline pumping of 4,100 AF in 2011. These projects are further discussed under the EWMPs in Section 7.
   2. *Conjunctive Supplemental Water Supply from Groundwater Sources*: The vast majority of MID wells are used conjunctively where they are on standby during years of adequate surface water supply and only operated when surface water supplies are inadequate. For example, between 1993 and 2001, the conjunctive supplemental groundwater supply wells were not used as a result of a continuous string of wet and above average years and the groundwater basin benefited from ample surface water deliveries. During the current drought, MID’s conjunctive supplemental water supply pumping has increased as Lake McClure storage has dwindled.

B. Privately Owned and Operated Wells: Private groundwater well owners within MID can be categorized into two groups: 1) growers that use their groundwater wells conjunctively to supplement MID water supplies when necessary; and 2) growers that rely strictly on private groundwater pumping. Estimated extraction rates for private groundwater pumping developed in the water balance range from 90,000 AF to an extreme of 259,000 AF in 2015.

Conjunctive Private Groundwater Pumping: A number of MID growers that own private wells use their wells to supplement surface water supplies when surface water supplies are inadequate for their crop's needs. These growers will also use their private wells for post-harvest irrigation and frost protection needs. Due to MID's inability to provide surface water for the first time in its history, these growers used their wells for full water supply in 2015.

There are approximately 30,000 acres within MID that rely solely on groundwater to meet their crop demands. It is anticipated that as the groundwater table continues to decline, water quality concerns continue to migrate from the west side of the San Joaquin River and with the onset of the Sustainable Groundwater Management Act, more and more of these MID growers that currently rely exclusively on private groundwater pumping will return to relying on surface water deliveries from MID. Should these growers return to MID, they would require approximately 100,000 AF of surface water deliveries to meet their crop's water demand.

4.5 Groundwater Conditions

A combination of a historic four-year drought and an unprecedented expansion of groundwater-dependent agricultural acreage took its toll on the Merced Groundwater Basin. The basin has seen the greatest plummet in groundwater levels since levels have been tracked. As the drought continued throughout 2015, the basin has become increasingly compromised:

- A large number of domestic well failures were witnessed over the last several years. Merced County has been distributing potable water to certain residents impacted by the compromised aquifers within the County. Most of the requests, according to the County Environmental Health Department, fall within MID boundaries as this is where the majority of private domestic pumping occurs.
- There has been an unprecedented rate of decline in groundwater elevations as a result of depleted natural recharge due to the lack of surface water application during the ongoing drought.
- The capacity of MID's wells has dropped over time. Currently, MID estimates it has a maximum pumping capacity of 90,000 AF over an 8 month irrigation season. In 1977, MID's pumping capacity was 190,000 AF over a similar time frame.
- The groundwater subsidence rate has increased dramatically in the southwest corner of the groundwater basin, along the San Joaquin River.
- Water levels in the open aquifers above the Corcoran formation is near depletion in many areas.
- The County of Merced passed a resolution, effective as of April 2015, placing restrictions on extractions below the Corcoran formation.
- DWR designated the Merced Groundwater Basin as a Critically Overdrafted Basin

Figure 4.3 shows a graph of static groundwater levels for MID wells since 1970. The red lines indicate dry years. The graph shows how drops in groundwater levels during the dry years are not regained in wet years, hence the continuous fall in the groundwater table. Figure 4-4 illustrates the extension and depth of the Corcoran formation.

Figure 4.3

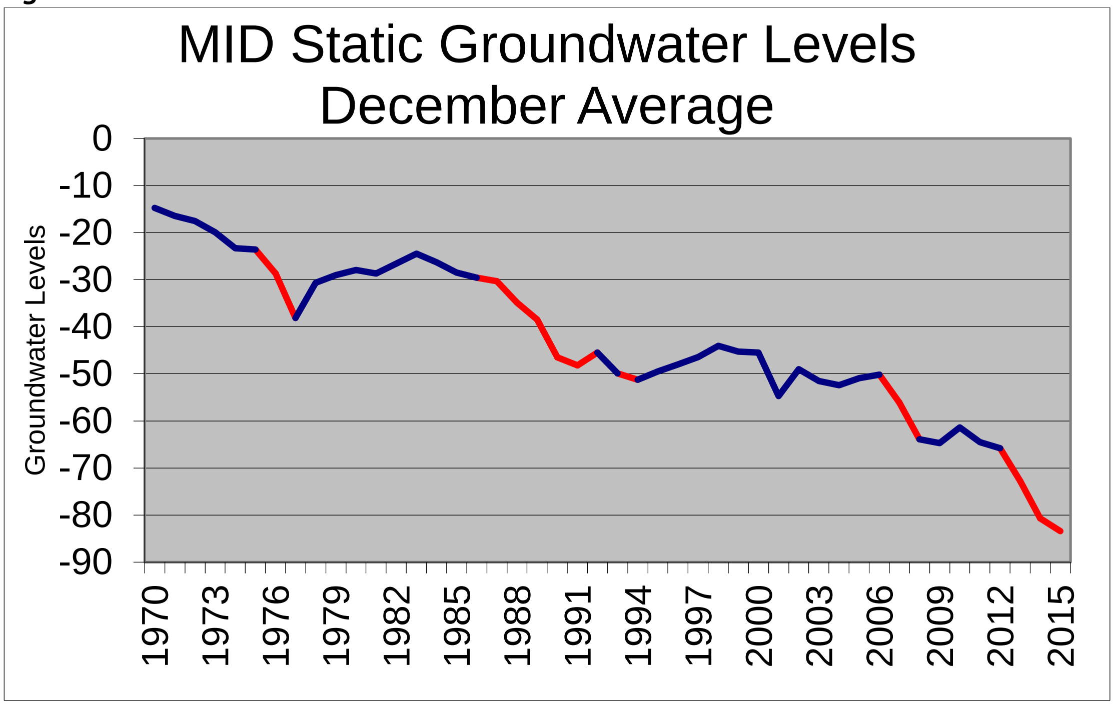


Figure 4.4 Illustrates the Extension and Depth of the Corcoran Formation

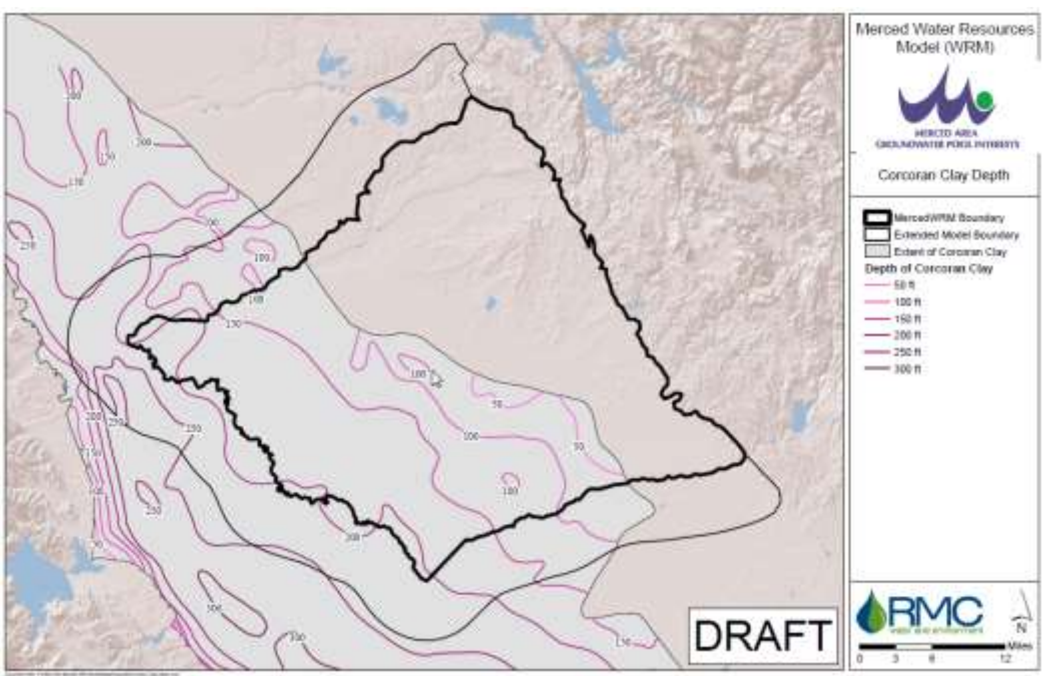
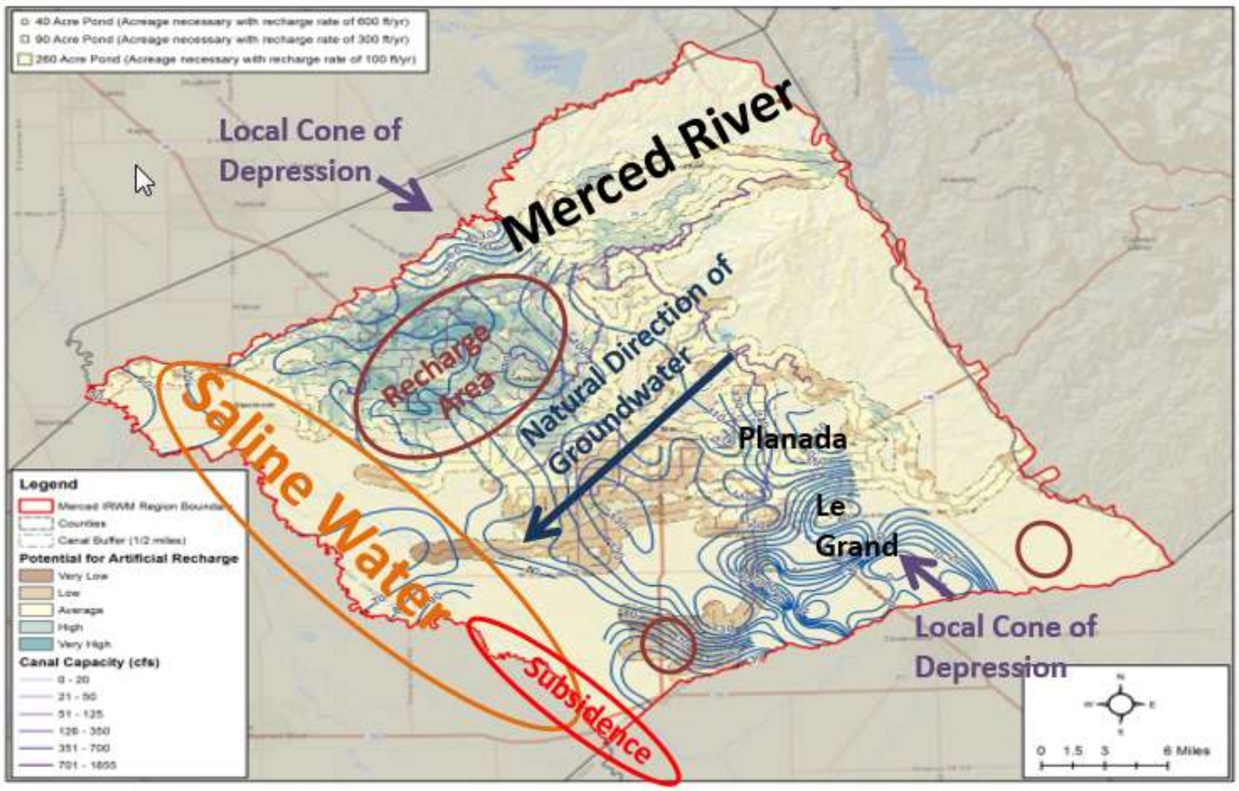


Figure 4.5 shows the location of potential recharge areas within the basin, the general direction of groundwater flow within the basin and the saline water sink under the San Joaquin River. The figure is intended to illustrate the challenges associated with reversing the groundwater trends. Note the location of potential recharge areas is limited to downstream areas within the southwest portion of the basin, right upstream of the of the saline water sink under the San Joaquin River. Although direct recharge may provide benefit to the basin, most of the unextracted groundwater recharge will end up in the saline sink or leave the basin. MID, in collaboration with its regional partners, is actively examining this situation. In-lieu recharge, as demonstrated by past MID operations, is the most effective method for recharge in large areas of the basin.

Figure 4.5 Location of Potential Recharge Areas within the Merced Basin



4.6 Other Water Supplies (§10826 (b)(3))

Currently, all of MID's water supplies come from the surface and groundwater sources described above. Nevertheless, as water supplies become more stressed due to natural and regulatory pressures, MID continues to pursue efforts to fortify the reliability and robustness of these supplies.

For example, MID is in negotiations with the City of Merced regarding using recycled water from the City of Merced's recently completed tertiary wastewater treatment plant. The District is also working with the Sierra Nevada Institute at UC Merced on a study evaluating the possibility of increasing runoff through improved watershed management. UC Merced received a grant under the IRWMP in 2014 to complete the study. Although the study is ongoing, preliminary model runs indicate there is a possibility that improved forest management could result in a 3% gain in runoff. Similar to the above two efforts, a number of projects have been identified to capture storm runoff in wet years for recharge via land application under the Merced Region IRWMP. The District is also considering various storage enhancement projects, including an increase in its carryover storage in New Exchequer Dam and a previously identified CALFED off-stream surface water reservoir project known as the Montgomery Reservoir.

4.7 Source Water Quality Monitoring Practices (§10826 (b)(4))

The surface water supply for the District includes rainfall and snowmelt from the Sierra Nevada Mountains, more specifically Yosemite National Park, and is of very high quality. Diverted surface water has an EC generally less than 20 µmhos/cm, with very low levels of nitrates and no detectable organics. This high quality water poses no restrictions for irrigation. MID has performed periodic water quality testing that dates to the 1980s, including testing within the Merced River, creeks utilized by the District, and active operational discharge locations. The District has made this information public through numerous submittals to the Central Valley Regional Water Quality Control Board under the Irrigated Land Regulatory Program (ILRP) and other federal and state agencies via other forums. See further discussion below.

4.8 Surface Water Sampling

Beginning in 1999, MID started a discretionary water quality sampling program for its grower's benefit to assess the quality of MID water supplies as it relates to agricultural suitability. The objective of this sampling is to give growers a source to analyze the quality of irrigation water provided to them each year and to keep the District appraised of water quality variations, if any, throughout the system.

Samples at diversion points are tested for electric conductivity (EC), Calcium (CA), Magnesium (Mg), Sodium (NA), Chlorides, CO_3, HCO_3, SO_4, Boron (B), NO_3, iron (FE), Manganese (Mn), pH. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). Specific collection points are further sampled for Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO). Samples are delivered to a State certified laboratory for analysis.

Growers may use this information to adjust their irrigation and develop crop management programs and the testing helps to assure the Districts customers that they are being provided with water of sufficient quality to grow local crops. Sampling results have illustrated to growers the superiority of MID's surface water supply as compared to groundwater, particularly pertaining to PH balance, lower EC (TDS) and primary metals and minerals.

4.9 Groundwater Sampling

Groundwater sampling includes selective groundwater wells that have suspected water quality problems. Samples are typically tested for EC, Ca, Mg, Na, Cl, CO_3, HCO_3, SO_4, B, NO_3, Fe, Mn, and pH.

4.10 Groundwater Quality

As expected, groundwater TDS and other mineral components vary by location. Generally, TDS tends to increase heading westerly with a range between 250 PPM to 600 PPM. All groundwater is suitable for agricultural use, although some crops are sensitive to certain minerals in the water. Almond trees are sensitive to carbonates and other salts, which impact yield and the health of the trees. Certain MID growers that rely exclusively on private groundwater pumping have reverted back to relying on MID surface water supplies due to these concerns and others are expected to follow in this pattern. Figures 4-6 to 4-9, excerpted from the Merced IRWMP technical, show various water quality characteristics of the Merced Groundwater Basin. More detailed description on the status of local groundwater quality could be found at:

http://www.mercedirwmp.org/files/Appendix%20D%20Salt%20and%20Nutrient%20Study%20Revised.pdf.

Figure 4-6 Groundwater Quality Type Merced IRWM Area

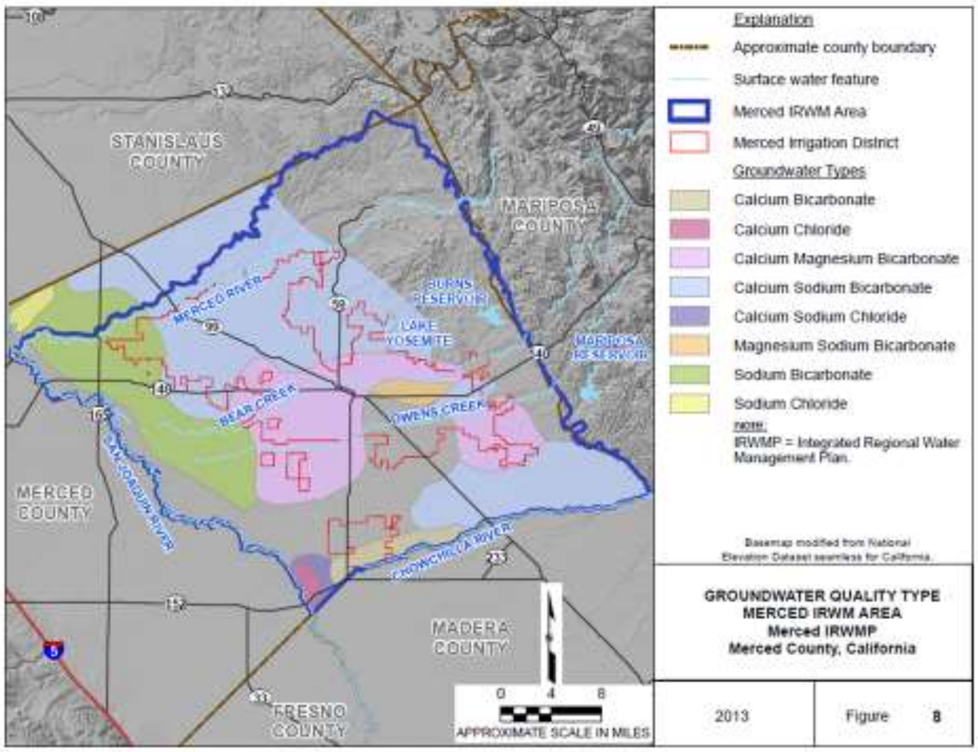


Figure 4-7 5 Year Average Distribution of Electrical Conductivity in Groundwater

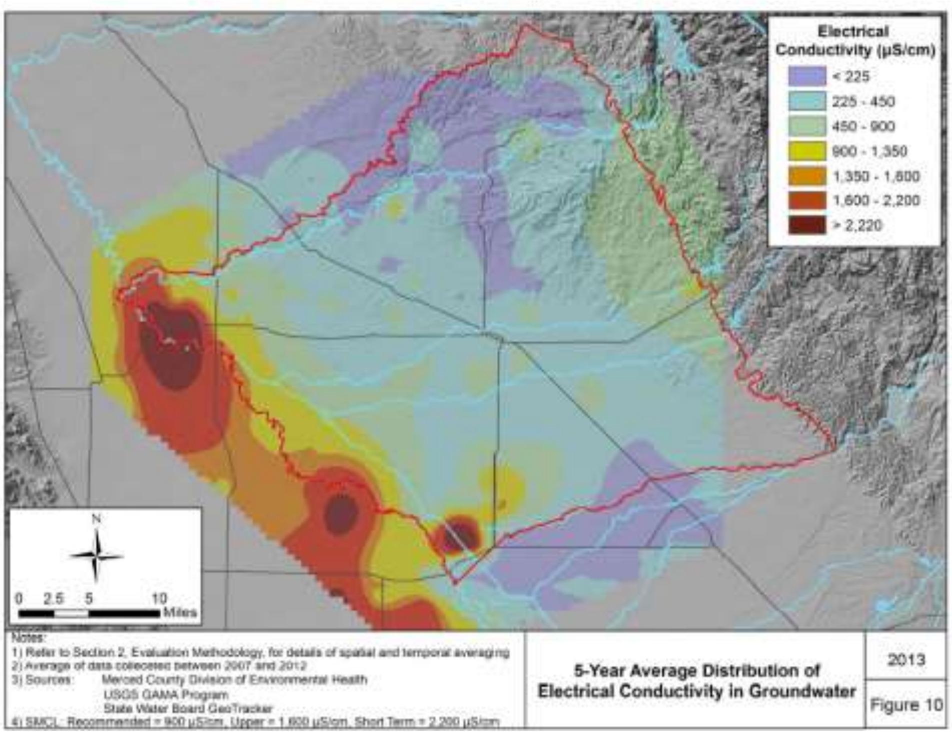


Figure 4-8 5 Year Average Distribution of Nitrate (as NO3) in Groundwater

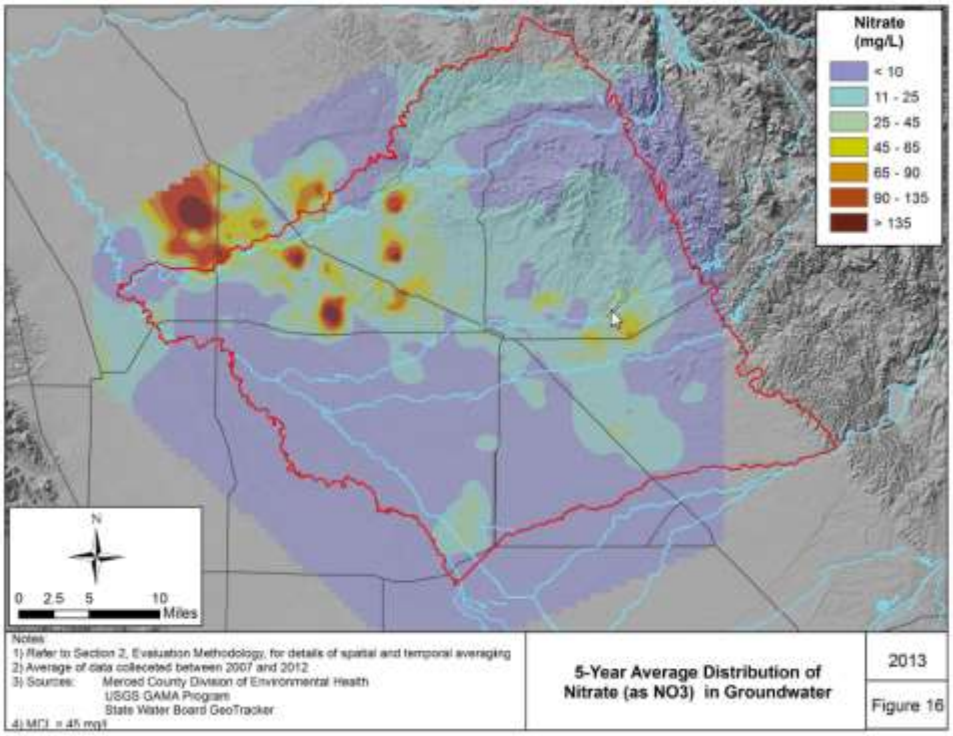
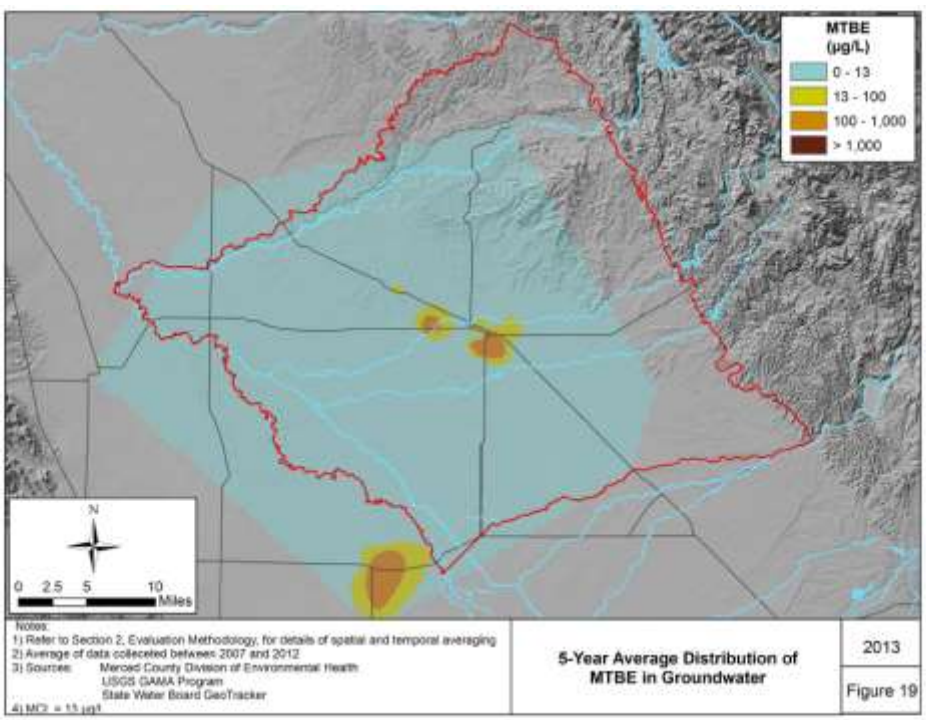


Figure 4-9 5 Year Average Distribution of MTBE in Groundwater



~End of Section~

The McCoy Lateral

Highlands 10,000 LF Pipeline Installation

SECTION 5. WATER BALANCE

MID utilized a range of years to best demonstrate the variations in applied water and consumptive and other water balance components as they are impacted by the year type and carry over storage in New Exchequer Reservoir. The years selected span from 2010 to 2015. Furthermore, MID has updated and refined its water balance development procedures as compared to the water balance included in MID's 2013 Plan. Major improvements associated with the current water balance include:

A. A water balance composed of three subareas:

1. MID water conveyance and distribution system
2. District irrigated lands receiving direct surface water and groundwater deliveries through MID facilities. These areas could also have private wells used on a supplemental basis.
3. District irrigated lands relying exclusively on private groundwater wells

B. Closures: The closures for the water balance equation for the above components are as follows:

1. MID Water Conveyance and Distribution System: canal seepage
2. District irrigated lands receiving direct surface and groundwater through MID facilities: private groundwater pumping
3. District irrigated lands relying totally on their private groundwater wells: private groundwater pumping

C. Most importantly, MID utilized METRIC, a remote sensing process calculating Evapotranspiration of vegetation within the District to calibrate the water balance.

The water balance model is developed such that outputs will continue to increase in accuracy as MID completes its SBX 7-7 corrective action plan (see Appendix F) and continues to improve the accuracy of individual grower delivery water measurements. The water balance is confined to MID-introduced surface and groundwater during the irrigation season. Tables 5-11 to 5-15 following demonstrates the variations of seasons and their correlation to the water-year types.

Figure 5.1 demonstrates the flow path and components of the water balance. The figure demonstrates inflows and outflows into the District. It also outlines the direction of the flow and closure terms.

Figure 5.1 Flow Path and Components of Water Balance

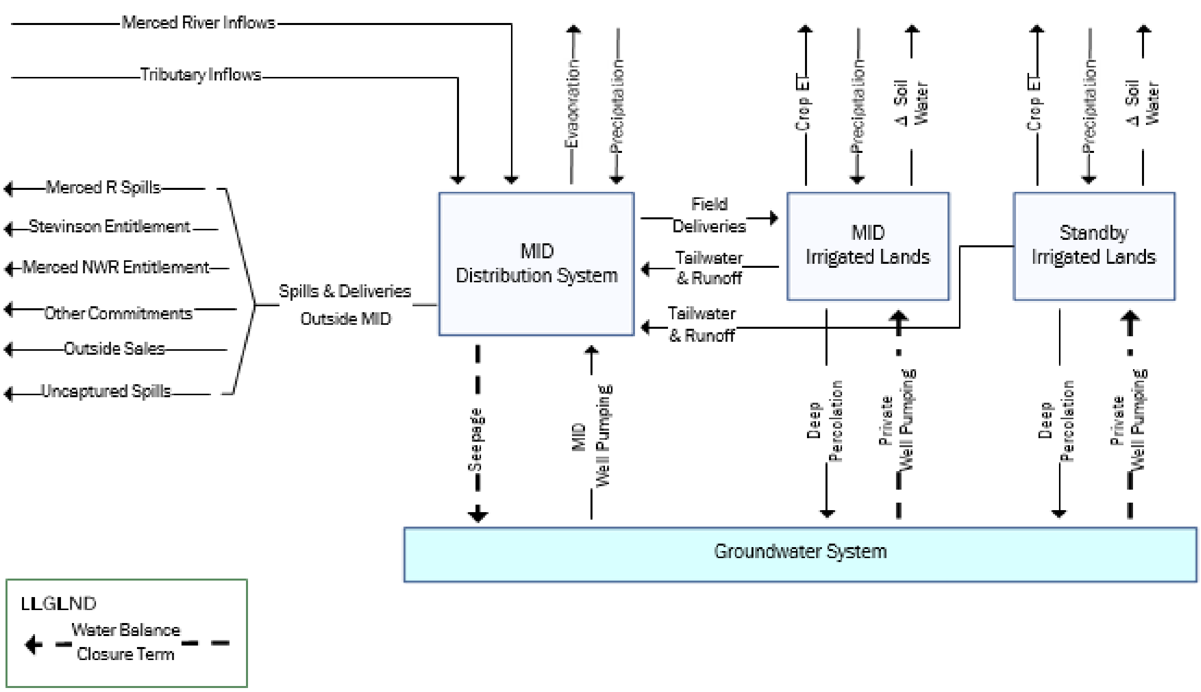


Table 5-1 demonstrates the components of the MID water conveyance and distribution system. As mentioned, METRIC was used to calibrate water deliveries and canal seepage was the closure factor. As part of its conjunctive management activities, MID has historically relied on its extensive unlined canal system as a means to provide recharge to the underlying groundwater basins to help facilitate the District's conjunctive pumping operations and MID grower's private pumping activities remain sustainable. The table also demonstrates the water balance for the irrigated lands within the District.

Table 5-1 ***Merced Irrigation District Water Balance Components Description***					
Accounting System	Flowpath Type	Water Balance Component	Data Type	Data Source	2012 Values (AF)
Distribution System	Inflows	Merced River Diversions	Measurement	Broad-crested weir on the Main Canal and contracted weir on the Northside Canal	485,833
		MID Groundwater Pumping	Measurement	Combination of flow meter and power meter readings and time of operation	17,074
		Tributary Inflows	Measurement	Stream gauge records on Bear, Burns, Black Rascal, Mariposa, and Owens Creeks	19,446
		Distribution System Precipitation	Calculation	CIMIS Station #148 (Merced) precipitation and surface area of canals and in-system reservoirs	1,031
		Tailwater and Runoff of Precipitation	Calculation	MID cropping and irrigation method data and tailwater net return flow of 0 to 10% on flood irrigated lands - Runoff of precipitation calculated in IDC based on land use and soils	29,418
	Outflows	MID Deliveries to Irrigated Lands	Measurement	Combination of flow meter and staff gauge and time of use records at all points of delivery	309,340
		Distribution System Seepage	Closure Term	Difference between distribution system total inflows and outflows	147,976
		Distribution System Evaporation	Calculation	CIMIS Station #148 (Merced) ETo x 1.05 and surface area of canals and in-system reservoirs	11,689
		Uncaptured Spills	Measurement	Flow measurements on all major spills and points of outside delivery. Calculated as excess of flows committed to entitlements and outside sales.	23,781
		Storm Throughflow	Calculation	Calculated as stream flows in excess of 900 cfs at the Bear Creek at McKee Road gauge during period of diversion. These storm driven flow events exceed the measurement capacity of the Bear Creek West Boundary gauge which measures other uncaptured spills and deliveries to Stevinson Water District.	65
		Operational Spills to Merced River	Measurement	Spill measurement at the end of the Northside Canal which returns flow to the Merced River	2,888

		Stevinson Water District	Measurement	Measurements of flows leaving the District through Bear and Owens Creeks and the Howard and McCoy laterals in accordance with the Stevinson agreement	26,400
		Merced National Wildlife Refuge	Measurement	Measurements of flows leaving the District through Deadman Creek	15,000
		Other Commitments	Calculation	DSO estimated flows based on typical flow rates and time of use to historic riparian rights users	9,707
		Outside Sales	Measurement	Measurements of flows leaving the District through points of delivery to outside users	5,955
Irrigated Lands	Inflows	MID Deliveries to Irrigated Lands	Measurement	Combination of flow meter and staff gauge and time of use records at all points of delivery	309,340
		Private Groundwater Pumping on Irrigated Lands with Direct Deliveries	Closure Term	Difference between total inflows and outflows on irrigated lands with direct deliveries	62,459
		Private Groundwater Pumping on Irrigated Lands without Direct Deliveries	Closure Term	Difference between total inflows and outflows on irrigated lands without direct deliveries	86,951
		Irrigated Lands Precipitation	Calculation	CIMIS Station #148 (Merced) precipitation and MID serviced irrigated area	53,742
	Outflows	Crop ET	Calculation	CIMIS Station #148 (Merced) ETo and precipitation, adjusted crop coefficients from METRIC analysis, MID cropping and irrigation method data, NRCS soil characteristics, minimum deep percolation adjusted for irrigation application efficiency, integrated with IDC root zone simulation model	317,499
		Tailwater and Runoff of Precipitation	Calculation	MID cropping and irrigation method data and tailwater net return flow of 0 to 10% on flood irrigated lands depending upon crop - Runoff of precipitation calculated in IDC based on land use and soils	29,418
		Deep Percolation	Calculation	See description under "Crop ET" above	147,674
		Change in Soil Water Storage	Calculation	See description under "Crop ET" above	17,901

Notes: All irrigated lands water balance components are calculated over a 1-March through 31-October growing season

5.1 Water Uses Within the MID Service Area (§10826 (b)(5))

Because of the active conjunctive use management practices of MID, the analyses of water usage presented in this section are based on recent MID activities to represent hydrology, cropping, and irrigation method. The years used to demonstrate variations in water supply and demand between wet and dry years are 2010 through 2015. The water year 2015 was included, in the sequence to demonstrate extreme drought conditions. Basing the analyses on a number of years (period of analysis) enables the water balance to better illustrate the nature of MID's conjunctive water management program. MID covers a gross area of 164,317 acres, of which an average 133,000 acres are irrigated with surface water, groundwater, or a combination of the two, all provided through MID's conjunctive management activities. The following paragraphs describe various types of water use within the District.

5.1.1 Agricultural (§10826 (b)(5) (A))

Table 5-2 lists the major crops grown in the MID service area for 2010 and 2013 and the average acreage of said crops over these years.

Table 5-2
Irrigated Area of Crops Grown on MID Customer Lands

Crop	Wet Year (2010)		Dry year (2013)		2010 and 2013 Average	
	Irrigated Lands with Direct Deliveries	Groundwater Dependent Customers	Irrigated Lands with Direct Deliveries	Groundwater Dependent Customers	Irrigated Lands with Direct Deliveries	Groundwater Dependent Customers
Orchards	35,031	10,873	40,984	10,701	38,008	10,787
Pasture	7,590	6,720	10,186	3,550	8,888	5,135
Alfalfa	12,931	4,485	7,230	755	10,081	2,620
Field Crops	18,267	1,736	21,283	2,024	19,775	1,880
Truck Crops	8,576	3,167	8,965	2,538	8,771	2,853
Grains	9,062	4,837	5,235	2,432	7,149	3,635
Vineyards	160	66	1,387	638	774	352
Rice	2,084	40	1,642	79	1,863	60
Idle	918	1,102	1,309	3,735	1,114	2,419
Unclassified	3,851	2,099	3,581	5,074	3,716	3,586
Total	98,470	35,125	101,802	31,526	100,136	33,325

Notes: Unclassified land use includes urban areas and small parcels generally consisting of landscape use.

Table 5-3 also presents average seasonal ET rates for these crops for the duration of MID surface water diversions constituting a normal irrigation season.

Table 5-3
Growing Season ET for Crops Receiving MID Deliveries

Crop	2010 - Wet Year ET (Inches)	2013 - Dry Year ET (Inches)	Average ET (Inches)
Orchards	30.7	32.7	31.7
Pasture	26.0	27.8	26.9
Alfalfa	31.6	33.9	32.8
Field Crops	27.5	29.2	28.4
Truck Crops	22.6	24.5	23.5
Grains	24.4	26.0	25.2
Vineyards	17.9	18.7	18.3
Rice	46.5	49.1	47.8
Idle	NA	NA	NA
Unclassified	7.7	8.3	8.0

Notes: The growing season is considered as March 1 through October 31.

Table 5-4
MID Irrigated Areas

Year	Water Year Type (SJR Index)	Total Serviced Irrigated Area (AC)	Total Irrigated Area with Direct Deliveries (AC)	Standby Only[1] (GW Dependent) Lands (AC)
2010	Above Normal	133,595	98,470	35,125
2011	Wet	133,579	97,415	36,164
2012	Dry	133,446	104,480	28,966
2013	Critical	133,328	101,802	31,526
2014	Critical	133,325	87,989	45,336
2015	Critical	133,134	38,321	94,813
2010 - 2012 Average		133,540	100,122	33,418
2013 - 2015 Average		133,262	76,037	57,225

[1] Standby Only = Total Serviced Irrigated Area-Total Irrigated Area with Direct Deliveries.

Figure 5-2 shows areas receiving MID water supplies in green, and areas that depend solely on private groundwater pumping are shown in blue.

Figure 5-2 2013 Distribution of Receiving MID Water and those that Rely Exclusively on Private Groundwater Pumping.

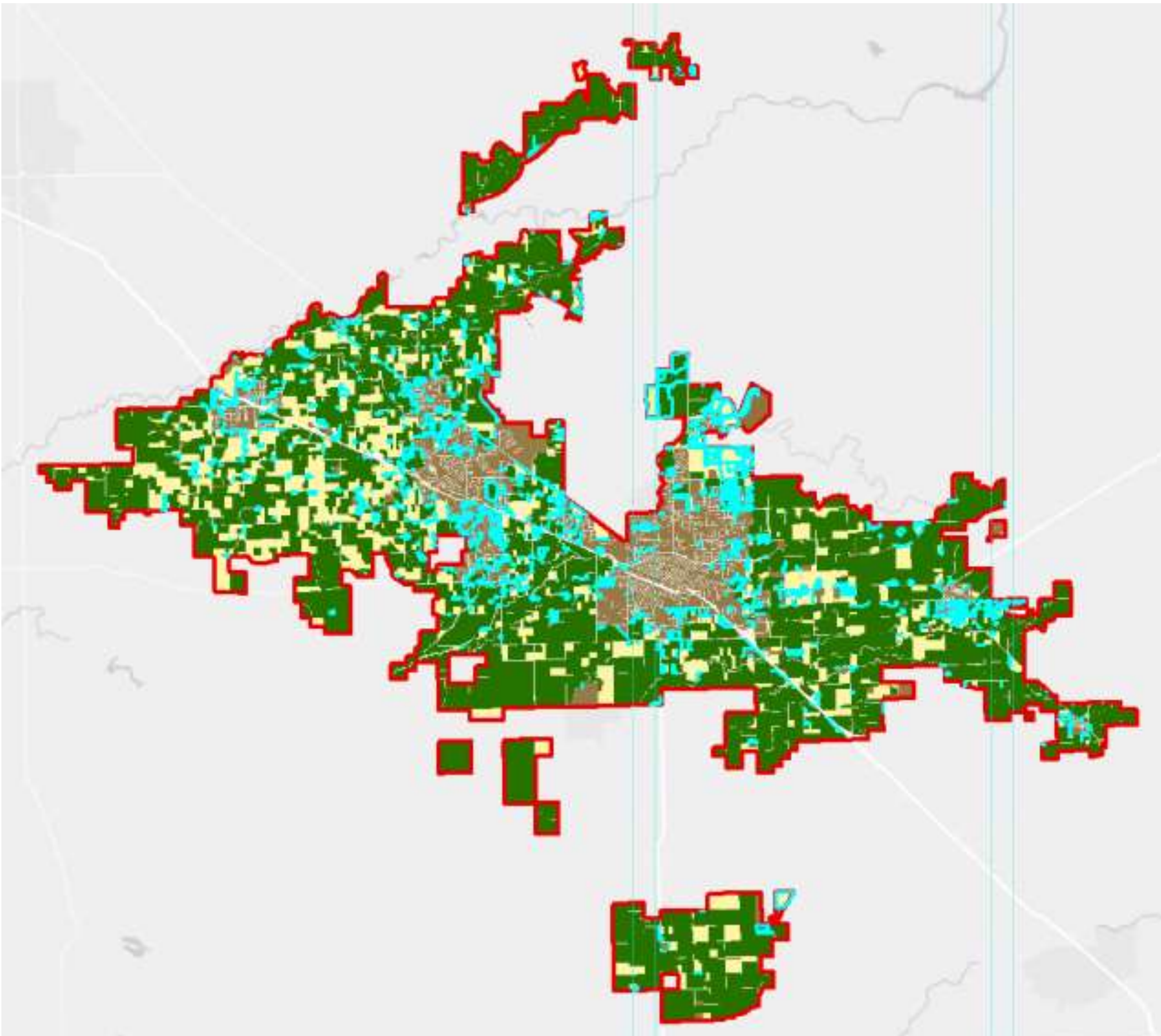


Table 5-5 demonstrates the average number of double-cropped acres reported within MID with the average total irrigated acreage. The double cropping irrigated acreage has varied based on cropping, hydrology, and commodity prices. Double cropping is expected to rise, trending increased value of agricultural commodities.

Table 5-5 ***Average Double-Cropped Acres***			
Multiple Crop Acreage (2000-2008)		**Multiple Crop Acreage (2010-2015)**	
Double Cropping	4,421	**Average Double Cropping**	1,960[1]

[1]The average is influenced by the drought of 2015 and lack of water.

5.1.2 Environmental (§10826 (b)(5) (B))

In addition to providing water supplies to MID growers, MID provides instream flows for environmental purposes through various regulatory, adjudicated and voluntary arrangements. Instream flows during the period of analysis are described below.

Regulatory Flows:

***FERC In-Stream Flows*:** MID's operates the Merced River Hydroelectric Project in accordance with a license issued by the Federal Energy Commission (FERC). These instream flows are released down the Merced River.

Other FERC License Flow Requirements: MID is required to provide flows to the Merced National Wildlife Refuge during MID's period of diversions between April and September.

State Water Rights License: Pursuant to MID's consumptive water right licenses, the District is required to supplement flows in the Merced River in October by providing 12,500 AF of water in addition to FERC minimum flow requirement in that month.

Voluntary Flow Releases:

DWR: MID releases flows in the Merced River with a minimum and maximum set range between November and March, through an agreement with the DWR. This agreement expires in 2017.

VAMP: MID released pulse flows in the Merced River per an agreement with USBR as part of the Vernalis Adaptive Management Plan (VAMP). This agreement expired on December 31, 2011.

USBR: MID entered into a two-year agreement with USBR for the release of flows in the Merced River to meet flow targets at Vernalis for environmental purposes in both 2012 and 2013.

East Bear Creek Unit: As part of its conjunctive management activities, MID provided environmental flows to the East Bear Creek Unit, located within Merced Groundwater Basin, in 2010, 2011, 2012, and 2013. The East Bear Creek Unit typically relies exclusively on groundwater extraction for its needs.

Table 5-6 presents information on environmental uses of MID water for both Merced River in-stream flows and flows through MID distribution system.

Table 5-6
Non-Consumptive Environmental Water Uses
Average Annual Volumes

Environmental Resources	Required	Voluntary Through an Agreement
FERC Instream Flows	√	
Other FERC License Flow Requirements (Merced National Wildlife Refuge)	√	
DWR Instream Flows		√
State Water Rights License (October Pulse Flow)	√	
VAMP Agreement (Pulse Flows) Agreement expired in 2011		√
USBR Water Transfer in 2012 and 2013 (Instream Flows)		√
Water Transfer to East Bear Creek Unit (Instream Flows)		√
IRWM Limited Wetland Maintenance		√

5.1.3 Recreational (§10826 (b)(5) (C))

MID maintains recreational facilities as requirements of its existing FERC license for the Merced River Hydroelectric Project (Project) as well as various non-Project recreation facilities.

Project Recreation Facilities

Project recreation facilities are located on the main stem of the Merced River at two Project reservoirs – Lake McClure and McSwain Reservoir. The Project consists of five developed recreation areas. Four of the recreation areas are located at Lake McClure, including McClure Point Recreation Area (RA), Barrett Cove RA, Horseshoe Bend RA, and Bagby RA. McSwain RA is located at McSwain Reservoir. Table 5-7 provides a brief summary of the developed recreation facilities at each of the Project reservoirs.

Non-Project Recreation Facilities

Non-Project recreation facilities include houseboat and marina facilities on Lake McClure and marina facilities on Lake McSwain, as well as several river access points along the Merced River. Lake Yosemite although owned and operated by MID for water storage and regulating purposes, is leased to Merced County for various recreation purposes such as day-use, swimming, fishing and boating.

Table 5-7
Summary of the Merced River Hydroelectric Project Recreation Facilities

Lake McClure Facilities

Recreation Area	Facility	Number of Campsites	Number of Picnic Sites	Number of Parking Spaces	Number of Boat Ramps
McClure Point	Campground	101	--	14	--
	Picnic Area	--	8	8	--
	Swim Beach	--	22	60	--
	Marina	--	--	50	--
	Boat Launch	--	--	140	1 (3 lanes)
Barrett Cove	Campground	275	--	39	--
	Swim Beach	--	13	30	--
	Boat Launch/Marina	--	6	267	2 (5 lanes)
	Overflow Parking	--	--	35	--
Horseshoe Bend	Campground	109	1	--	--
	Swim Beach	--	12	50	--
	Boat Launch	--	--	49	1 (2 lanes)
Bagby	Bagby Campground	30	--	221	--
	Sheperd's Point Primitive Area	15	--	--	--
	Boat Launch	--	--	31	1 (2 lanes)
Total	**15**	**530**	**62**	**994**	**5**

Lake McSwain Facilities

Facility	Number of Campsites	Number of Picnic Sites	Number of Parking Spaces	Number of Boat Ramps
Campground	112	1	28	--
Picnic Area	--	12	52	--
Group Picnic Area	--	1	55	--
Swim Beach	--	6	15	--
Informal Day Use Area	--	8	24	--
Marina	--	--	20	--
Boat Launch	--	--	89	1 (2 lanes)
Total	**112**	**28**	**283**	**1**

5.1.4 Municipal and Industrial (§10826 (b)(5) (D))

MID makes three small diversions from Lake McClure, each related to water supply. The diversions are so minor they have minimal if any effect on Project operations, and MID anticipates that the diversions will continue unchanged for at least the next five (5) years. These are:

- The Lake Don Pedro Community Service District (LDPCSD) withdraws from a location just north of Barrett Cove Marina up to about 700 AF or water annually for water supply. LDPCSD diverts pursuant to a water purchase agreement with the District, and is subject to the same rules as MID for water out of storage from New Exchequer Reservoir. For example, LDPCSD cannot make withdrawals when the reservoir is below the minimum regulatory pool of 115,000 AF.
- Less than 1,000 AF of water is withdrawn annually by MID recreation facilities at three locations along Lake McClure.
- The McClure Boat Club, a small development adjacent to the Project, diverts about 25 AF at a point near the development. The boat club withdraws water from a pump on a float that rises and falls with the reservoir elevation and has an intake 10 feet below the float.

The City of Merced received all its drinking water from Lake Yosemite until 1917. Since then, most municipal consumers within the Merced Groundwater Basin have relied on groundwater as their source of supply.

As part of its conjunctive use program, the District supplies landscape and pond water to boat manufacturers and school districts who have supplemented groundwater supplies with surface water. MID is currently working with the cities of Merced and Livingston on similar concepts regarding their potable water supply systems, which are both exclusively groundwater pumping systems. MID and the City of Merced are currently evaluating opportunities to provide MID surface water to landscape areas in public parks, supplementing a significant portion of their demand on the underlying aquifer and reducing pressure on their municipal groundwater supply wells. The City of Livingston is working with the District to evaluate reducing reliance on an aquifer with marginal water quality. MID intends to continue pursue these efforts and to continue to seek out opportunities to expand its in-lieu groundwater recharge efforts within urban areas.

Urban areas occupy approximately 18,200 acres within the MID. The Merced Groundwater Basin, Groundwater Management Plan reported a total of approximately 43,700 AF of urban groundwater use in 2014. This total includes both groundwater pumped by urban utilities and groundwater produced by small private residential water systems, commercial businesses and industrial plants not served by the major utilities. Groundwater use is projected to grow despite effective water conservation efforts. Table 5.8 presents information on M&I usage of groundwater within the Merced Groundwater Basin and compares 2007 to 2014 and 2015 pumping volumes.

The 1996 municipal total of approximately 40,000 AF is compared to a municipal total of approximately 43,700 AF in 2014.

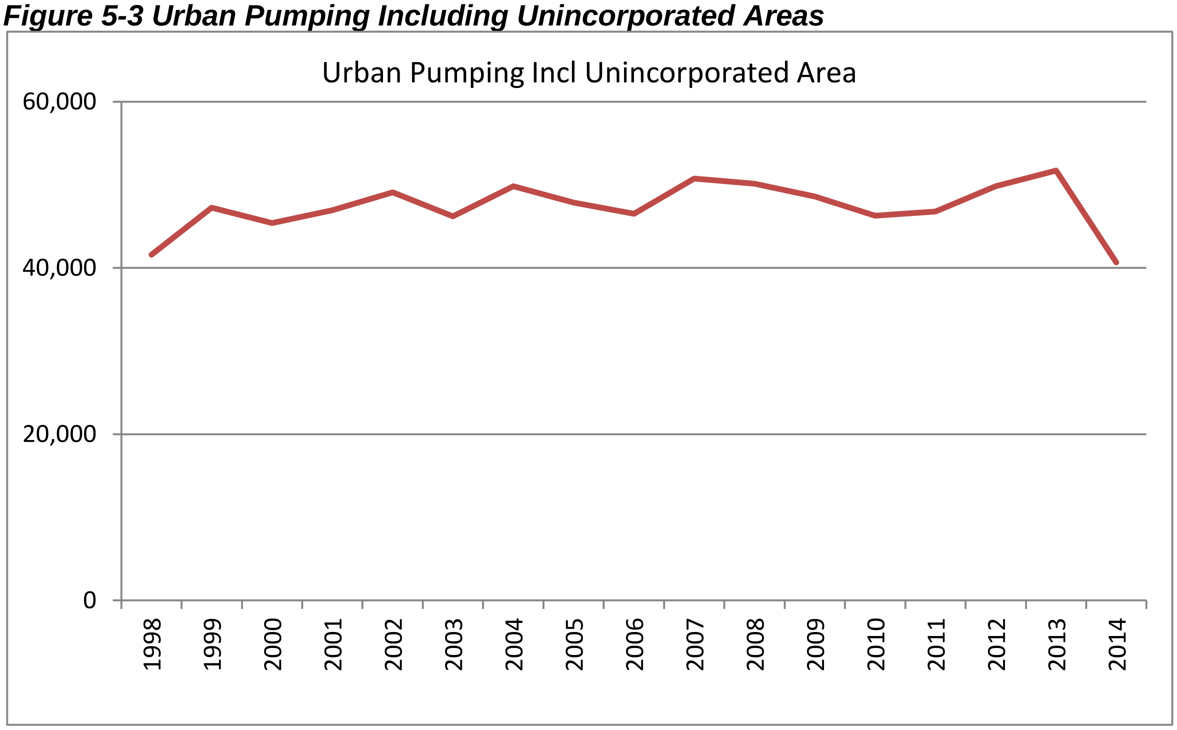
Urban water demands in the City of Merced form the largest single component of the municipal and industrial demand category. Historical data showed an overall trend of declining per capita water use. The droughts of 1976-77, 1987-92, and 2007-2008 contributed to this downward trend, partly by creating public awareness of water shortages.

Table 5-8
Municipal Pumping – AF

Area	2007	2014	2015
Black Rascal Water District, Le Grand and Planada CSD, Meadowbrook, Winton Water and Sanitation District	5,170	4,065*	N/A
City of Merced	24,383	25,234	17,852
City of Atwater	9,916	6,865	6,302
City of Livingston	7,287	7,370	6,719
Unincorporated areas	3,494	4,000	N/A
Total	50,250	47,534	N/A
*Black Rascal did not report from 10/2012 – 07/2015			N/A

Figure 5-3 shows total urban groundwater usage between 1998 and 2015.

Figure 5-3 Urban Pumping Including Unincorporated Areas



5.1.5 Groundwater Recharge (§10826 (b)(5) (E))

The MID water balance shows annual deep percolation from applied water on grower's fields and canal seepage (the main components of groundwater recharge) varied between 133,000 AF and 313,000 AF during the water balance period of 2010 through 2015, 2015 being the minimum recharge year.

The fluctuation is dependent on hydrology, length of irrigation season, and irrigation methods. Deep percolation decreased as MID growers converted from flood irrigation to low volume irrigation methods Deep percolation rates per acre are expected to continue to decrease due to the ongoing trend where permanent crops are replacing row crops, as permanent crops typically apply low volume pressurized irrigation methods with lower percolation tendencies.

In dry years, the District relies on recharge from stored deep percolation and water distribution system seepage to supplement surface water deliveries. This recharge is essential in sustaining a supply and demand balance for in-District acreage serviced by MID distribution facilities and In-District acreage that rely totally or partially on groundwater extracted by private wells.

In addition to intentional passive recharge through water distribution seepage, MID's conjunctive management activities have include highly effective in-lieu and direct recharge operations. Table 5-9 shows in-lieu recharge efforts that resulted in over 32,000 acre-feet of average annual recharge.

Table 5-9
In-Lieu Recharge – Applied in Years of Adequate Water Supply Only
Average Annual Volumes (AF)

Activities	Drought	Average
Reduced Overall Usage of MID owned and operated Groundwater wells	0	11,000
Reduced Base Line Pumping – Low Head Boosters Serving High Grounds	0	1,700
Merced Highlands Pilot Project	0	1,350
Merced Groundwater Conservation Incentive Program	0	4,365
In-Basin Water Transfers	0	15,400
Total		32,115

The District's direct recharge efforts currently consist of two groundwater recharge basins: one is on the northerly area of the District and the other is a historical basin close to the south end of the District, in the town of El Nido. MID has recently received funding through the IRWMP process to upgrade the basin and install various automation and monitoring equipment. The northerly basin, MID's Cressey Recharge Basin, is located north of the town of Winton. The project was completed in 2011 after 11 years of studies and pilot tests, which started in 2000 with seed funding from DWR for the initial studies. MID then received additional funding from DWR in 2014 to expand this project.

It should be noted that an effective conjunctive management effort relies on robust surface water supplies. Passive recharge decreases as surface water supplies decrease. As to be expected, as the drought continued, annual in-lieu recharge decreased to almost 0 acre-feet in 2015. Similarly, in years of inadequate surface water supplies, no stored water is delivered to direct recharge basins. MID is concerned that ongoing regulatory processes that seek to reduce available surface water supply to MID will severely impact MID's conjunctive management activities in the same manner as the current drought.

5.1.6 Transfers and Exchanges (§10826 (b)(5) (F))

Water Transfers

Due to the upgradient location of Lake McClure and the location of MID's water conveyance and supply facilities, MID relies exclusively on the Merced River and local tributaries for its' surface water supply and its conjunctive well field for supplemental water supplies. MID has historically implemented water transfers, primarily from Lake McClure and the Merced River, as a seller. Transfers have been included in MID's financial, conjunctive management and environmental deliberations since at least 1967.

In 1967, MID executed a multi-purpose, long term transfer with DWR known as the Davis-Grunsky Contract which calls for the voluntary release of water to the Merced River between the months of November and March for fishery purposes. Funds from the transfer were used to establishing MID's recreational facilities at Lake McSwain, Lake McClure and along the Merced River. This Contract expires December 31, 2017.

As part of its conjunctive management activities, MID has also re-operated Lake Yosemite and Crocker Dam, both pre-1914 facilities that receive local runoff, to implement water transfers with the State's Environmental Water Account and the Bureau of Reclamation's Water Acquisition Program. MID made a number of transfers to the Environmental Water Account and East Bear Creek Unit, a local federal refuge that primarily relies on groundwater supplies. In addition to strategic environmental water transfers, MID engages in water supply water transfers, primarily for agricultural purposes. Water is also conveyed by MID to a number of water users located downstream of the District, as well as to certain parcels with riparian entitlements whose natural watercourses have been incorporated into the MID distribution system.

Water Exchanges

Similar to the above discussion regarding the upgradient location of Lake McClure and the location of MID's conveyance and supply facilities, exchanging surface water is difficult. Groundwater in the periphery of MID is limited and utilized by parcels outside the District. MID relies exclusively on the Merced River and local tributaries for its surface water supply and its conjunctive well field for supplemental water supplies. MID was able to exchange around 7,000 AF in 2007 from the Stevinson Water District by purchasing a portion of the water committed by MID to Stevinson Water District.

5.1.7 Other Water Uses (§10826 (b)(5) (G))

MID occasionally provides water for construction work within its service area. The amounts do not normally exceed 25 AF, annually. The water is mainly supplied from groundwater sources as it is preferred being naturally clear of debris in nature. MID also provides water for fire suppression, mainly from Lake McClure as well as recreational uses and agricultural frost protection.

5.2 Drainage from the MID Service Area (§10826 (b)(6)).

Flows leaving the District without meeting a water commitment may be considered an operational discharge or spill. MID's concerted efforts over the last several decades, including a capital improvement plan, focused on water conservation and spill reduction, among other things, has dramatically improved MID's ability to control operational discharges. Most spills have been networked such that they discharge to another canal and the former spill water is put to beneficial use helping to meet MID's demand and various water commitments.

The following is a list of the District's major operational discharge locations.

- The Livingston Canal Spill and the Garibaldi Lateral Spill: Both of these facilities can discharge to the Merced River. MID has completed projects that drastically reduced flows through these spills and they are typically only used for storm water discharges or emergencies.
- Several other laterals can physically spill to the river, but due to their low capacity, typically do not have measurable or significant operational discharges.
- Bear Creek, Owens Creek, Duck Slough, Howard Lateral and McCoy Lateral are all facilities that can be utilized by the District to meet a downstream water commitment to the Stevinson Water District of 26,400 AF annually. MID maintains recorders on all these facilities that discharge to the East Side Canal.
- The Atwater Drain is a man-made facility that terminates at the East Side Canal. The District is working on designs to reduce spills down the Atwater Drain by redirecting flows to meet MID commitments.
- Mariposa Creek/Duck Slough spills into the East Side Canal. Historically, the District used the creek to meet downstream commitments. MID completed improvements in the 1990s that drastically reduced discharges to the creek.
- Deadman Creek is used to meet MID's annual commitment of up to 15,000 acre-feet to the Merced National Wildlife Refuge per MID's existing FERC license. Flows are measured with a weir on the creek at the refuge's eastern boundary.
- The Livingston Drain is a man-made facility that terminates in Bear Creek. The District is currently constructing a project that will allow redirection of flows in the drain to meet downstream water commitments.

The Lingard "F," El Nido Dam, El Nido Canal, El Nido "A" and El Nido "B" are smaller spills that are typically only active in wet years and actual losses are negligible. Similarly, there are other minor laterals and drains with spills primarily active in wet years, such as the Fesler Drain that are usually dry and any spill typically dissipates over private property.

All natural creeks mentioned above are intercepted by the East Side Canal but naturally terminate in the San Joaquin River. Natural waterways that serve as conveyances for deliveries within MID may also carry agricultural drainage, storm drainage and operational discharges. Waterways of this type are designated within the MID water balance as being parts of the MID delivery system to the point of their most downstream delivery. However, downstream of all MID delivery points, watercourses that receive drainage water are designated as drains.

5.2.1 Drainage System Water Quality

MID's Water Quality Monitoring Program

MID has participated in the Irrigated Lands Regulatory Program (ILRP) administered by the Central Valley Regional Water Quality Control Board (RWQCB) since the initiation of the program in 2003 with the issuance of Monitoring and Reporting Program Order No. R5-2003-0827 for individual dischargers under Resolution No. R5-2003-0105. The ILRP regulates discharge of irrigation return flows and storm water from those lands to surface waters. A majority of the irrigated acres in the central valley have regulatory coverage in the ILRP by participating in Water Quality Coalitions that are locally managed by agricultural interests. The Coalitions conduct an extensive amount of monitoring and work with growers to address identified water quality problems. Others participate as

Individual Dischargers and perform their own water quality monitoring and reporting. MID participated as an Individual Discharger for the years reported herein.

According to the Order, Individual Dischargers were required to develop and implement a Monitoring and Reporting Program Plan (MRP Plan) to assess the impacts of waste in discharges from irrigated lands, and where necessary, to track progress of existing or new management practices implemented to improve the impact of these discharges on water quality and/or to protect waters of the state and its beneficial uses. The reports required by this Order are required to evaluate impacts of waste discharges on Waters of the State and to determine compliance with the terms and conditions of the Waiver. MID prepared and submitted to the RWQCB for review and approval by the Executive Officer an MRP Plan that met the minimum conditions of the MRP.

In 2010, the RWQCB conducted a review of the ILRP program and concluded that the data gathered over the last 6 years indicated that MID is a low threat discharger and does not appear to create water quality problems. Based on the review, the District was given the opportunity to determine future coverage under the ILRP and elected to join the East San Joaquin Water Quality Coalition (ESJWQC). MID is no longer considered an Individual Discharger and will no longer be generating reports under the ILRP program. Rather, MID will be represented under the regional MRP of the ESJWQC.

In accordance with the IRLP, the MRP achieved the following objectives:

- Assessed the impacts of waste discharges from irrigated lands to surface water.
- Established the effectiveness of management practices and strategies to reduce discharges of wastes that impact water quality.
- Determined concentration and load of waste in these discharges to surface waters.
- Evaluated compliance with existing narrative and numeric water quality objectives to determine if additional implementation of management practices is necessary to improve and/or protect water quality.
- During MID's FERC relicensing efforts, MID conducted a water quality study primarily focused on Lake McClure and McSwain Reservoir. MID found that general water quality in the Project Area is high (i.e., most analytes were reported at non-detect to just above reporting limit concentrations) and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project reservoirs.

5.3 Water Accounting (§10826 (b)(7))

5.3.1 Quantification of MID Water Supplies-(§10826 (b)(7)(A))

Surface Water Supplies

Table 5-10 summarizes annual distribution of surface water diversion to MID's irrigation conveyance system over the period from 2010 through 2015. These values include pre-1914 surface water and ground water supplies, in addition to precipitation and tailwater supplies. As explained above, except for incidental runoff from local tributaries, the vast majority of the MID's surface water supplies are released from Lake McClure.

Table 5-10
MID Distribution System Water Balance Inputs
(Values are in acre-feet)

Flowpath Type	Water Balance Component	2010	2011	2012	2013	2014	2015
Inflows	Merced River Diversions	532,019	606,566	485,833	383,424	218,351	13,319
	MID Groundwater Pumping	6,972	4,113	17,074	56,714	45,717	36,858
	Tributary Inflows	22,471	84,535	19,446	11,099	643	0
	Distribution System Precipitation	1,022	1,509	1,031	204	81	26
	Tailwater and Runoff of Precipitation	22,026	30,531	29,418	17,009	19,439	13,640
	Total Inflows	584,510	727,254	552,802	468,450	284,232	50,177

Groundwater Supplies

Annual volumes of groundwater pumped from MID and private wells for the period 2010 through 2015 are presented in Table 5-11. The private pumpage by MID customers are based on the results of the water balance which illustrates the variability of the water extracted in relation to hydrology and surface water availability. Private pumping was further subdivided into two groups: private groundwater pumping used conjunctively to supplement deliveries of MID surface water (Lands with Direct Delivery), and private groundwater pumping of parcels that rely exclusively on private groundwater pumping for their water supply needs (Lands without Direct Delivery).

The average pumping for each of the three groups varied drastically between normal water supply years and years of the recent drought. Total groundwater pumping ranged from 116,018 acre-feet in the wettest year to 392,171 acre-feet during 2015, the latest year of the ongoing drought.

Table 5-11
Groundwater Pumping, MID Service Area

Year	Water Year Type (SJR Index)	MID GW Pumping (AF)	MID Customer Private Well Pumping		Total Ag Pumping
			Lands with Direct Delivery(AF)	Lands without Direct Delivery(AF)	
2010	Above Normal	6,972	27,607	93,138	127,717
2011	Wet	4,113	18,148	93,757	116,018
2012	Dry	17,074	62,459	86,951	166,484
2013	Critical	56,714	100,570	83,982	241,266
2014	Critical	45,717	167,332	123,644	336,693
2015	Critical	36,858	96,056	259,257	392,171
2010 - 2012 Average		9,386	36,072	91,282	136,740
2013 - 2015 Average		46,430	121,319	155,628	323,377

Recycled Water

Four wastewater sources exist in the vicinity of MID, including three municipal wastewater treatment plants (WWTP), one each for the Cities' of Merced, Livingston and Atwater. A portion of the wastewater from Merced's WWTP is applied on land adjacent to the plant. MID and the City are evaluating opportunities for the use of recycled water, in excess of the City's land application and other needs, by the District to meet portions of its downstream commitments.

The City of Livingston discharges their effluent downstream of MID conveyance facilities and does not present opportunities for meeting District commitments. The City of Atwater has contracted with a private landowner for use of the City's entire wastewater effluent discharge.

MID and the University of California have discussed the possibility of using wastewater generated by the new UC Merced campus for conjunctive management and other purposes, since the campus is located over 12 miles from the City of Merced's WWTP and upslope from MID's commitments.

Other Water Uses

All surface and groundwater supplies to the MID have been described in the preceding paragraphs.

5.3.2 Tabulation of Water Uses (§10826 (b)(7)(B))

Water uses in MID are tabulated in the water balance database developed for this Plan.

Applied Water

Estimated farm deliveries of District-supplied surface water over the period 2010 through 2015 are demonstrated in Table 5-12.

Table 5-12
MID Applied Irrigation Water Summary

Flowpath Type	Water Balance Component	Units	2010	2011	2012	2013	2014	2015
Sources	MID Deliveries to Irrigated Lands – Estimated Surface Water Component	AF	258,075	261,637	299,229	232,229	115,572	7,264
	MID Deliveries to Irrigated Lands – Estimated Groundwater Component	AF	3,245	1,557	10,112	33,384	24,127	20,100
	Private Groundwater Pumping on Irrigated Lands with Direct Deliveries	AF	27,607	18,148	62,459	100,570	167,332	96,056
	Private Groundwater Pumping on Irrigated Lands without Direct Deliveries	AF	93,138	93,757	86,951	83,982	123,644	259,257
Totals	Total Applied Irrigation Water	AF	382,065	375,099	458,751	450,165	430,674	382,677
	Total Serviced Irrigated Area	AC	133,595	133,579	133,446	133,328	133,325	133,134
	Average Unit Applied Irrigation Water	AFA	2.86	2.81	3.44	3.38	3.23	2.87
	Average Proportion of Applied Water Comprised of Groundwater Pumping	%	32%	30%	35%	48%	73%	98%

Consumptive Use

Evapotranspiration of applied water over the period 2010 through 2015 has averaged about 300,000 AF per year. Table 5-16 MID Irrigated Lands Water Balance, shows ET values for MID crops for the different years.

Net Recharge: Seepage, Deep Percolation, GW Pumping

Net Recharge for this water balance constituted from canal seepage, deep percolation, and groundwater pumping. Values for net recharge are shown in Table 5-13.

Table 5-13
Net Recharge: Seepage, Deep Percolation, GW Pumping

Year	Water Year Type (SJR Index)	Canal Seepage (AF)	Growing Season Deep Percolation: Lands with Direct Delivery (AF)	Growing Season Deep Percolation: Lands without Direct Delivery (AF)	Total Recharge (AF)	MID Groundwater Pumping (AF)	MID Customer Private Well Pumping: Lands with Direct Delivery (AF)	MID Customer Private Well Pumping: Lands without Direct Delivery (AF)	Net Recharge (AF)	Net Recharge (AFA)
2010	Above Normal	143,906	98,557	32,058	274,520	6,972	27,607	93,138	146,803	1.1
2011	Wet	181,107	98,483	33,883	313,473	4,113	18,148	93,757	197,455	1.5
2012	Dry	147,976	119,768	27,906	295,650	17,074	62,459	86,951	129,165	1.0
2013	Critical	121,949	106,664	23,281	251,894	56,714	100,570	83,982	10,628	0.1
2014	Critical	94,867	92,971	35,718	223,556	45,717	167,332	123,644	-113,136	-0.8
2015	Critical	21,454	37,472	74,954	133,880	36,858	96,056	259,257	-258,291	-1.9
2010 - 2012 Average		157,663	105,603	31,282	294,548	9,386	36,072	91,282	157,808	1.2
2013 - 2015 Average		79,423	79,036	44,651	203,110	46,430	121,319	155,628	-120,266	-0.9

Seepage from the MID water conveyance and distribution system is estimated to average 157,663 AF per year for the period between 2010-2012, while it decreased to an average of 79,423 for the drought period between 2013 and 2015. Because much of the canal system is unlined, seepage tends to vary throughout the irrigation season and by year type. For example, seepage generally increases when higher flow volumes are conveyed (although seepage as a proportion of flow is greatest during months when little water is being conveyed) and as the length of the irrigation season increase. A greater seepage rate tends to occur during low precipitation years. Seepage rates are also impacted by underlying soil formations.

Within MID's water conveyance and distributions system, about half of the seepage occurs in the utilized portions of creeks, sloughs and drains, as well as regulating reservoirs and off channel inundated areas.

Deep Percolation resulting from on farm irrigation during the irrigation season averages 136,885 between 2010 and 2012. However, deep percolation drops to an average of 123,687 AF between 2013 and 2015.

Groundwater Pumping is composed of groundwater pumped from both MID and private groundwater wells. Private pumping is furthered subdivided into two groups: private groundwater pumping used conjunctively to supplement deliveries of MID surface water; and private groundwater pumping of parcels that rely exclusively on private groundwater pumping for their water supply needs.

Groundwater pumping from MID groundwater wells averaged as low as 9,386 AF during the years of adequate surface water supply between 2010 and 2012. In comparison, MID's conjunctive groundwater pumping increased to an average of 46,430 AF during the critically dry years of 2013 through 2015.

Private groundwater pumping used conjunctively to supplement deliveries of MID surface water averaged 36,072 AF between 2010 and 2012, years of adequate surface water supplies. Pumping increased to an average of 121,319 AF between the drought years of 2013 through 2015. Private groundwater pumping from parcels that rely exclusively on private groundwater pumping for their water supply needs average 91,208 AF between 2010 and 2012, and averaged 155,628 AF between 2013 and 2015.

Net Recharge over the period between 2010 and 2015 went from positive in years of adequate water supply to negative as the ongoing drought continued. Net recharge for 2010 through 2012 averaged 157,000 AF. However, recharge was a negative number during the drought, indicating higher groundwater extraction than the concurrent passive, in-lieu and direct recharge rates, averaging -120,266 AF for all agricultural activities within MID boundary. Table 5-14 shows the range of annual seepage volumes estimated for the period 2010 through 2015.

Table 5-14
MID Net Groundwater Recharge

Year	Water Year Type (SJR Index)	Canal Seepage (AF)	Growing Season Deep Percolation: Lands with Direct Delivery (AF)	Growing Season Deep Percolation: Lands without Direct Delivery (AF)	Total Recharge (AF)	MID GW Pumping (AF)	MID Customer Private Well Pumping: Lands with Direct Delivery (AF)	MID Customer Private Well Pumping: Lands without Direct Delivery (AF)	Net Recharge (AF)	Net Recharge (AF per Acre)
2010	Above Normal	143,906	98,557	32,058	274,520	6,972	27,607	93,138	146,803	1.1
2011	Wet	181,107	98,483	33,883	313,473	4,113	18,148	93,757	197,455	1.5
2012	Dry	147,976	119,768	27,906	295,650	17,074	62,459	86,951	129,165	1.0
2013	Critical	121,949	106,664	23,281	251,894	56,714	100,570	83,982	10,628	0.1
2014	Critical	94,867	92,971	35,718	223,556	45,717	167,332	123,644	-113,136	-0.8
2015	Critical	21,454	37,472	74,954	133,880	36,858	96,056	259,257	-258,291	-1.9
2010 - 2012 Avg.		157,663	105,603	31,282	294,548	9,386	36,072	91,282	157,808	1.2
2013 - 2015 Avg.		79,423	79,036	44,651	203,110	46,430	121,319	155,628	-120,266	-0.9

All input components of the water balance are presented in Table 5-15, including Merced River diversions, MID groundwater pumping, tributary inflows, distribution system precipitation, tailwater water and runoff of precipitation, deliveries to irrigated lands, Distribution system seepage, distribution system evaporation, uncaptured spills, storm flows, operational spills, and commitments to the Stevinson Water District, Merced National Wildlife Refuge, other Commitments, water transfers and total outflows.

The table also presents average values for the period from 2010 to 2015 of sources of water supplying the MID's canal distribution system and delivered directly to the growers' fields. It is not practical to give a representative value for surface drainage leaving the District, particularly because MID has very little acreage having tile drainage. In addition, flows leaving the District are a combination of storm and drainage flows, downstream commitment flows and operational discharges.

Table 5-15
MID Distribution System Water Balance Inputs
(All values are in acre-feet)

Flowpath Type	Water Balance Component	2010	2011	2012	2013	2014	2015
Inflows (AF)	Merced River Diversions	532,019	606,566	485,833	383,424	218,351	13,319
	MID Groundwater Pumping	6,972	4,113	17,074	56,714	45,717	36,858
	Tributary Inflows	22,471	84,535	19,446	11,099	643	0
	Distribution System Precipitation	1,022	1,509	1,031	204	81	26
	Tailwater and Runoff of Precipitation	22,026	30,531	29,418	17,009	19,439	13,640
	Total Inflows	***584,510***	***727,254***	***552,802***	***468,450***	***284,232***	***50,177***
Outflows (AF)	MID Deliveries to Irrigated Lands	261,320	263,194	309,340	265,613	139,699	27,364
	Distribution System Seepage	143,906	181,107	147,976	121,949	94,867	21,454
	Distribution System Evaporation	10,485	10,891	11,689	11,708	9,908	710
	Uncaptured Spills	97,844	167,920	23,781	12,356	1,871	649
	Storm Throughflow	0	24,972	65	0	0	0
	Operational Spills to Merced River	2,073	2,451	2,888	3,466	1,878	0
	Stevinson Water District	26,400	26,400	26,400	26,400	23,913	0
	Merced National Wildlife Refuge	15,000	15,000	15,000	15,000	5,113	0
	Other Commitments	11,105	9,648	9,707	11,959	6,983	0
	Outside Sales	16,377	25,671	5,955	0	0	0
	Total Outflows	***584,510***	***727,254***	***552,802***	***468,450***	***284,232***	***50,177***

Distribution System Seepage: Previous Table 5-15 presents estimated system seepage during the irrigation season. Seepage is the closure component in the water balance for the MID distribution system component. Seepage varied between 181,107 AF in the wettest year of 2011 to 21,454 AF in 2015, a year of very limited surface water supplies and where almost half of the distribution system was dry.

Distribution System Evaporation*:* Annual evaporation from MID canals is estimated to average 9,200 AF per year for the period between 2010 and 2015. As shown in Table 5.15, the highest evaporation volume of 11,708 AF occurred in 2013. Early in the current drought, the high seepage rate is due to a combination of fully charged canals and a low precipitation year. In comparison evaporation decreased when surface water supplies were limited, such as in 2014 and plunged to 649 AF in 2015 due to the lack of surface water availability.

Operational Discharges: Due to MID's water conservation and spill reduction efforts, spills will vary widely between water year types as MID applies its water rights to maximize beneficial use. For example, in 2011, a wet water year, uncaptured spills amounted to 167,920 AF. Between 2012 and 2013, dry water years at the early stages of the drought, spills averaged 18,000 AF. In 2014 and 2015, which were dry water years well into the historic drought and extremely limited surface water supplies, the average spill was about 1,000 AF. MID is continuing to implement projects that will allow it to further reduce spills in dry water years.

Storm Flows: Due to the interconnected nature of MID's water conveyance and distribution system with natural creeks, uncaptured storm flows pass through portions of the MID system. Noted as Storm Through flow, MID allowed 24,972 AF to pass from local tributaries in 2011. That number could increase to 60,000 AF in some El Nino years when spring storms coincide with the irrigation season. MID recorders along its west boundary register all flows collectively, including Storm Through flow, MID commitment flows, operational discharges and water transfers.

Water Used for Leaching and Cultural Practices: Because of the high quality of the surface water supply, and because approximately 88 percent of applied water consists of surface water deliveries, with the remainder consisting of varying, but acceptable water quality of MID groundwater pumping and private groundwater pumping, leaching is not a significant factor in irrigation management at MID. Water used for cultural purposes is included in the District's accounting.

Municipal and Industrial Water Use: Municipalities and industries in the MID service area rely on groundwater except for a limited number of users who supplement groundwater supplies with MID surface water. M&I usage is not included in the water use accounting used to develop the MID water balance.

Water Used for Environmental Purposes: Please refer to Section §10826 (b)(5) (B) -Water Uses within the MID Service Area. In summary, MID provides up to 15,000 AF to the MNWR as a condition of its FERC license for the Project.

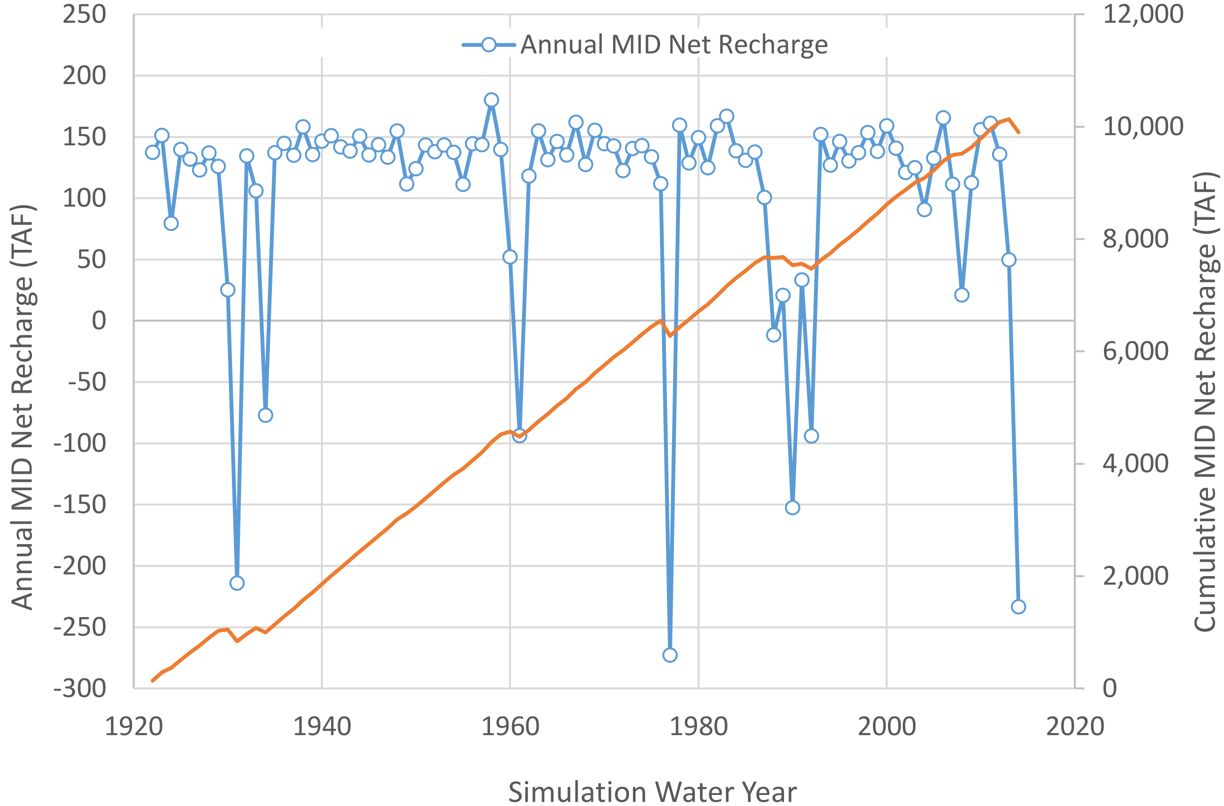
Water Used for Recreational Purposes: Please refer to Section §10826 (b)(5)(C) - Water Uses Within the MID Service Area. There is no explicit diversion or consumption of MID water for recreational purposes, and, hence, there is no need to include this use in the MID accounting framework.

Groundwater Recharge and Conjunctive Use: Simulated annual groundwater pumping by MID and MID customers represents groundwater withdrawals, and the simulated distribution seepage and deep percolation over irrigated lands during the irrigation season represents groundwater recharge resulting from MID operations. The difference between these two terms is the MID net recharge.

Figure 5-4 shows MID net recharge on an annual and cumulative basis over a 93 year simulation period. Important observations from this simulation are as follows:

- During 82 percent of the years simulated, the annual MID net groundwater recharge ranges between 100,000 and 170,000 AF
- Over the 93 year period, only 8 years result in a net withdrawal of groundwater from storage
- The cumulative net groundwater recharge over the 93 year period is 9,900 TAF

Figure 5-4 Long-term MID Net Groundwater Recharge Simulated for Current Land Use and Reservoir Operations



Water Exchanges or Transfers: Water transfers and water exchanges included in the water balance (2010-2015) are as follows:

1. Voluntary Water Transfers
   a. Lake McClure/Merced River: 46,920 AF
   b. Reoperation of Lake Yosemite and Crocker Dam: 7,742 AF

2. Water Exchanges: NA

Estimated Deep Percolation: Estimated annual average of deep percolation for the following years:

2010 - 2012: 294,548

2013 - 2015: 203,110

Table 5-16 illustrates the components of the water balance of irrigated lands and the resulting deep percolation. Table 5-17 shows the resultant deep percolation by water balance component.

Table 5-16
MID Irrigated Lands Water Balance
(All values are in acre-feet)

Flowpath Type	Water Balance Component	2010	2011	2012	2013	2014	2015
Inflows	MID Deliveries to Irrigated Lands	261,320	263,194	309,340	265,613	139,699	27,364
	Private Groundwater Pumping on Irrigated Lands with Direct Deliveries	27,607	18,148	62,459	100,570	167,332	96,056
	Private Groundwater Pumping on Irrigated Lands without Direct Deliveries	93,138	93,757	86,951	83,982	123,644	259,257
	Irrigated Lands Precipitation	64,720	80,954	53,742	11,421	31,554	16,531
	Total Inflows	***446,785***	***456,053***	***512,492***	***461,586***	***462,228***	***399,207***
Outflows	Crop ET	302,751	300,368	317,499	308,146	298,451	264,075
	Tailwater and Runoff of Precipitation	22,026	30,531	29,418	17,009	19,439	13,640
	Deep Percolation	130,615	132,367	147,674	129,945	128,689	112,426
	Change in Soil Water Storage	-8,607	-7,212	17,901	6,486	15,648	9,066
	Total Outflows	***446,785***	***456,053***	***512,492***	***461,586***	***462,228***	***399,207***

Table 5-17
Deep Percolation by Water Balance Component
(All values are in acre-feet)

Year	Water Year Type (SJR Index)	Growing Season Deep Percolation		Total Recharge
		Lands with Direct Delivery	Lands without Direct Delivery	
2010	Above Normal	98,557	32,058	274,520
2011	Wet	98,483	33,883	313,473
2012	Dry	119,768	27,906	295,650
2013	Critical	106,664	23,281	251,894
2014	Critical	92,971	35,718	223,556
2015	Critical	37,472	74,954	133,880
2010 - 2012 Average		105,603	31,282	294,548
2013 - 2015 Average		79,036	44,651	203,110

Flows to Saline Sink or Perched Water Table: Some of MID's water flows are believed to migrate to either saline sinks or non-recoverable perched water tables. Determining these values require a high resolution hydrogeologic analysis, and are not included in this accounting.

Total Recycled Water: This has been discussed above under Section §10826 (b)(7).-Water Accounting.

Water Leaving the Water Supplier's Service Area: Water leaving the MID service area exits primarily via two pathways 1) operational discharge, drainage and entitlement flows which leave the District as streamflow; and 2) evaporation and evapotranspiration. These pathways have been discussed above.

Groundwater flow across MID boundaries is considered negligible for the water balance. Table 5-18 shows values of uncaptured spills.

Table 5-18
MID Uncaptured Spills Summary

Year	Water Year Type (SJR Index)	Uncaptured Spills (AF)
2010	Above Normal	97,844
2011	Wet	167,920
2012	Dry	23,781
2013	Critical	12,356
2014	Critical	1,871
2015	Critical	649
2010 - 2012 Average		96,515
2013 - 2015 Average		4,959

Other: All water uses that are accounted for by the MID have been presented in the above discussion.

5.3.3 Overall Water Budget (§10826 (b)(7)(C))

Major factors that impact MID's water budget include hydrology, length of irrigation season, carryover storage in Lake McClure, water allocations to MID growers, and climate. Table 4-2 quantifies these major factors for the duration of the period of analysis.

Primary sources of data for the water balance include:

- MID records on water diversion and water deliveries.
- Field cropping information from MID records and DWR surveys.
- MID's facility GIS for water storage, conveyance and distribution system physical characteristics, such as length of lined and unlined canals, pipelines, creeks, drains, etc.
- Other MID records, surveys, etc.
- METRIC (Mapping Evapotranspiration at High Resolution with Internal Calibration) evaluations of District-wide consumptive use were available for 2008, 2010, and 2013. METRIC utilizes CIMIS data for deriving ET.

Irrigation method (flood, drip, etc.) by parcel was available for years 2012 and later.

Irrigated Lands Water Balances

The District was divided into 10 Local Service Areas (LSA), shown in Figure 5-5. The areas were divided by major distribution system arteries, and mainly follow the distribution areas managed by MID Distribution System Operators. A Daily Time Series (AF/Day) was then developed for each area. The general process for development of the irrigated lands water balances is outlined in Figure 5-6.

Figure 5-5: Local Service Areas

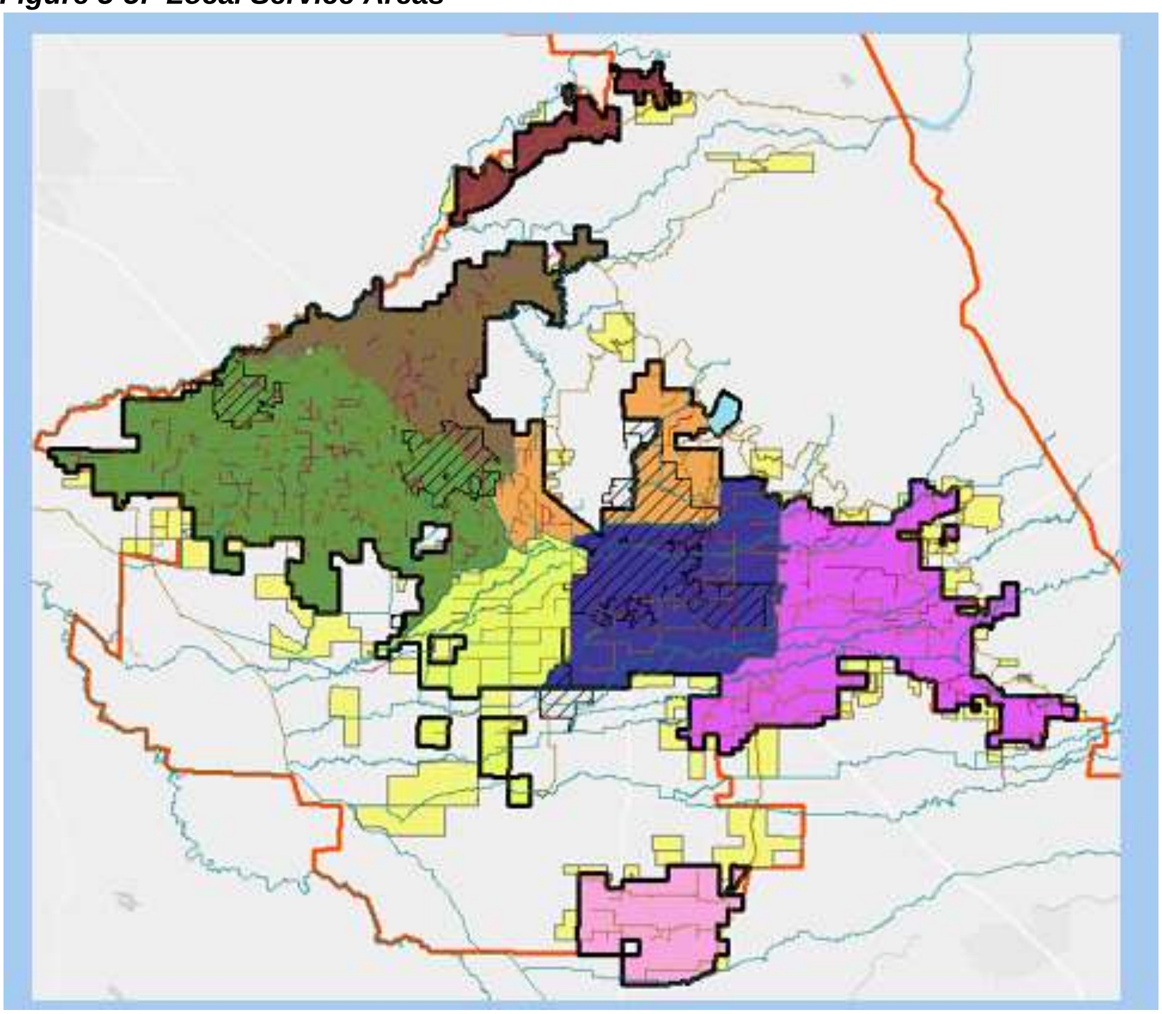
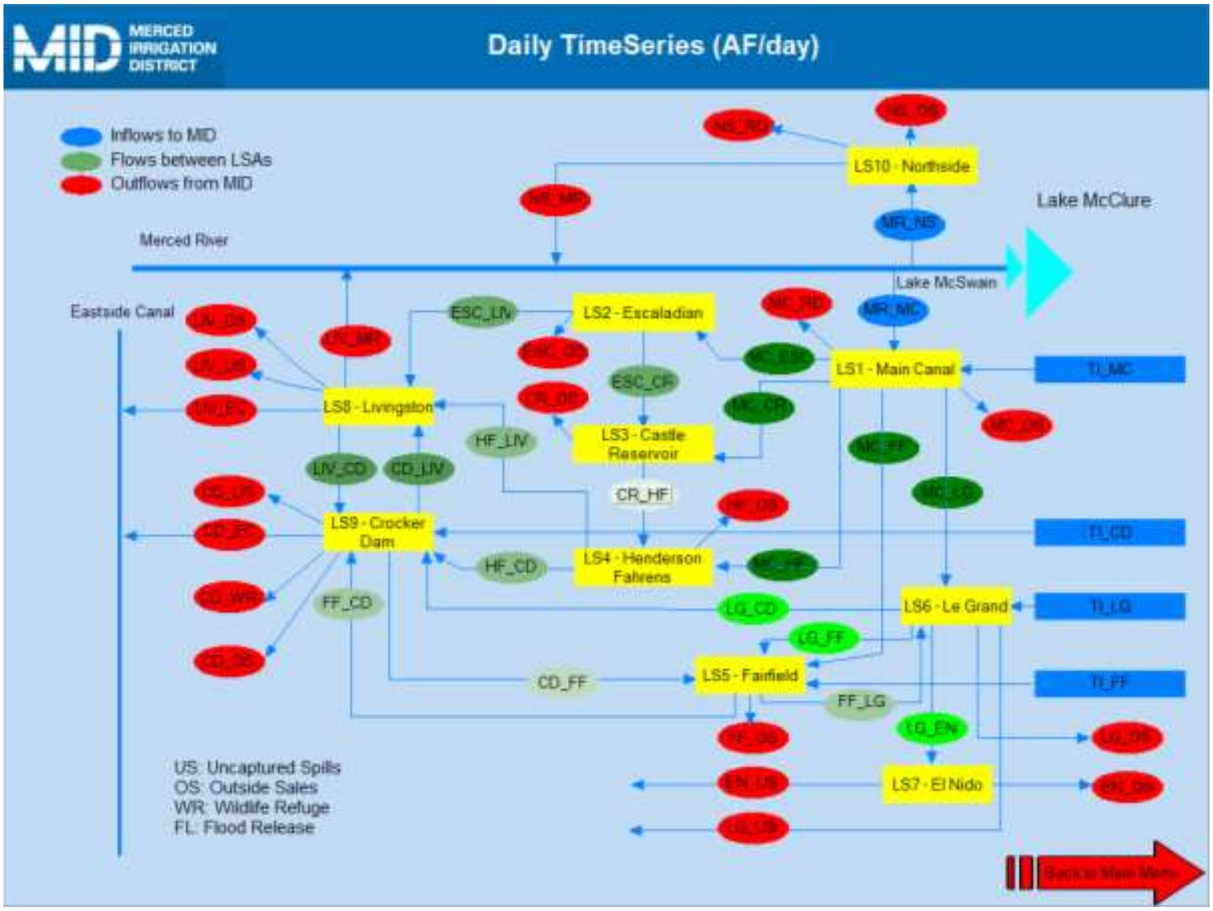


Figure 5-6 Daily Time Series (AF/day)



In the first step of the process consumptive use factors are the combination of crop coefficients and irrigation management factors, used in the following equation.

$$ET_c = ET_o \cdot K_c \cdot IMF \qquad (1)$$

Where:

ET_c = actual crop evapotranspiration

ET_o = grass reference evapotranspiration

K_c = crop coefficient for ideal conditions

IMF = irrigation management factor

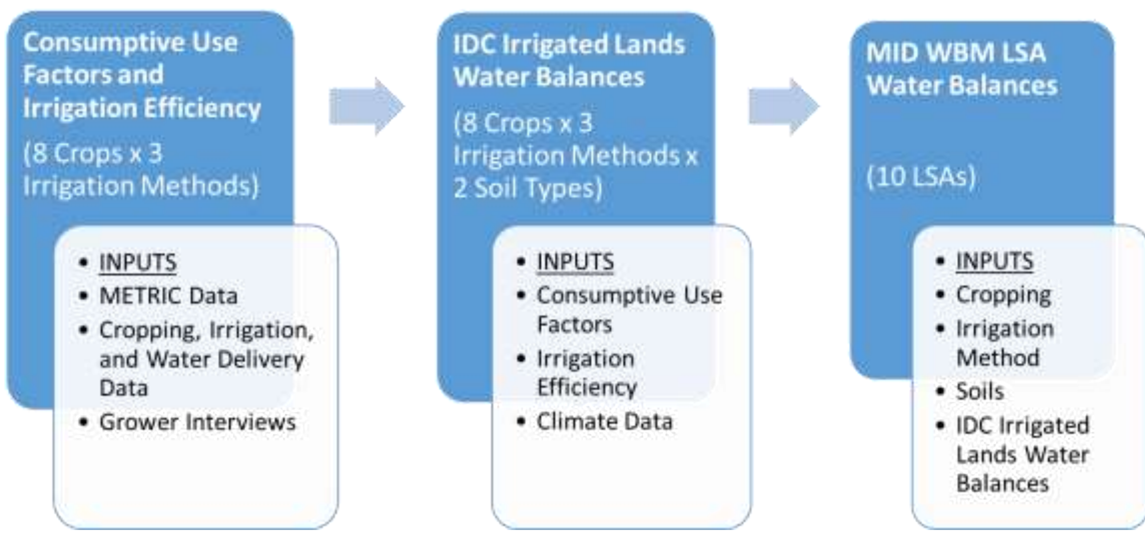
These factors allow estimation of crop consumptive use or ET_c and are needed to support future projections of field irrigation water demands based on changing hydrologic conditions and cropping and irrigation method patterns.

Table 5-19
Major Factors Impacting MID's Water Balance

Year	Main Canal Period of Diversion		Length of Diversion Period (Days)	Water Year Type (SJR Index)	Available Water (inches)	Water Year Precipitation (inches)	Growing Season Precipitation (inches)	Growing Season ET_o (inches)
	Start Date	End Date						
2010	25-Mar	31-Oct	221	Above Normal	36+	10.7	5.8	49.4
2011	10-Mar	31-Oct	236	Wet	36+	17.1	7.3	49.5
2012	1-Mar	31-Oct	245	Dry	36+	7.5	4.8	52.2
2013	8-Mar	31-Oct	238	Critical	28.8	7.9	1.0	53.1
2014	18-Apr	18-Oct	184	Critical	1.7	5.0	2.8	52.1
2015	1-Jul	12-Jul	12	Critical	0	6.1	1.5	49.8
2010 - 2012 Average					36+	11.8	6.0	50.4
2013 - 2015 Average					15.25	6.3	1.8	51.7

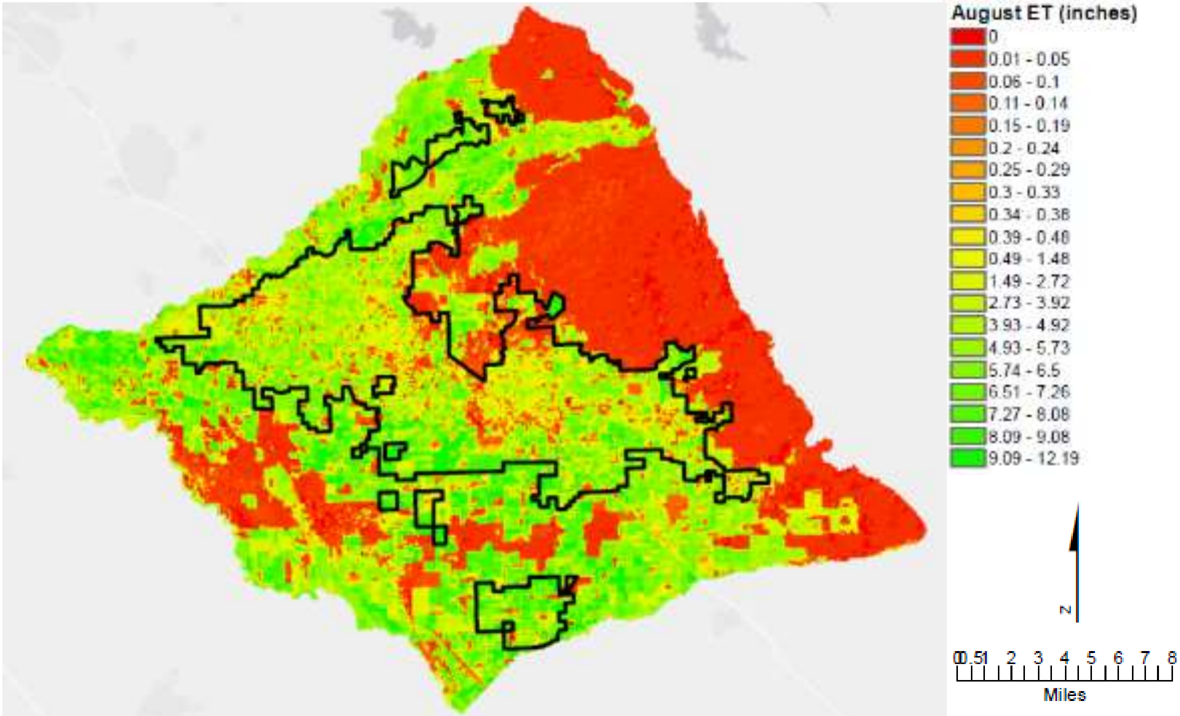
Note: In 2015, MID groundwater was delivered for a 213 day period between April 1 and October 31.

Figure 5-7 Process for Development of Irrigated Lands Water Balance Inputs to MID WBM



MID used METRIC data, a special ET_o analysis, to develop consumptive use factors for the water balance. METRIC data was developed for the MID water balance by the Irrigation Training and Research Center at Cal Poly San Luis Obispo (ITRC). METRIC is an analysis of the surface energy balance based on remotely sensed surface temperature data and ground based climate data. This analysis was performed on the spatial resolution of an approximately 30-meter Landsat grid cell across the entire Merced Region under the Merced IRWMP, as defined in that plan. An example image for August 2013 is presented in Figure 5-8.

Figure 5-8 E-22METRIC ET_c Image for August 2013



California Irrigation Management Information System (CIMIS) station (Station No. 148) combined with Kc values generated by ITRC for the CIMIS ET_o Zone 12, which contains Merced. Irrigation management factors were then calculated by rearrangement of Equation 1. Results of this analysis are presented in Table E-4.

Table 5-20
Irrigation Management Factors Determined from METRIC Data Analysis

Crop Category	Irrigation Management Factor			ITRC K_c Pattern
	Drip/Micro	Flood	Sprinkler	
Orchard	0.83	0.72	0.86	Almonds
Pasture	0.55	0.62	0.55	Pasture and Miscellaneous Grasses
Alfalfa	0.80	0.78	0.80	Alfalfa Hay and Clover
Field Crops	1.00	1.03	1.00	Corn and Grain Sorghum
Truck Crops	0.74	1.07	0.70	Average of "Tomatoes and Peppers" and "Potatoes, Sugar beets, Turnips, etc."
Grains	0.57	0.57	0.57	Pasture and Miscellaneous Grasses
Vineyards	1.03	0.94	1.03	Immature Grapes Vines with 50% Canopy
Rice	NA	1.20	NA	Rice

MID developed Applied Irrigation Water estimates based on a normalization of the data by ITRC over a long period consisting of a variety of water year types. MID Applied Irrigation Water estimates are shown in Table 5-21.

Table 5-21 MID Applied Irrigation Water Summary								
Flowpath Type	Water Balance Component	Units	2010	2011	2012	2013	2014	2015
Sources	MID Deliveries to Irrigated Lands - Estimated Surface Water Component	AF	258,075	261,637	299,229	232,229	115,572	7,264
	MID Deliveries to Irrigated Lands - Estimated Groundwater Component	AF	3,245	1,557	10,112	33,384	24,127	20,100
	Private Groundwater Pumping on Irrigated Lands with Direct Deliveries	AF	27,607	18,148	62,459	100,570	167,332	96,056
	Private Groundwater Pumping on Irrigated Lands without Direct Deliveries	AF	93,138	93,757	86,951	83,982	123,644	259,257
Totals	Total Applied Irrigation Water	AF	382,065	375,099	458,751	450,165	430,674	382,677
	Total Serviced Irrigated Area	AC	133,595	133,579	133,446	133,328	133,325	133,134
	Average Unit Applied Irrigation Water	AFA	2.86	2.81	3.44	3.38	3.23	2.87
	Average Proportion of Applied Water Comprised of Groundwater Pumping	%	32%	30%	35%	48%	73%	98%

5.4 Water Supply Reliability (§10826 (b)(7))

Historically robust, MID's water supplies, both surface and groundwater supplies, are being challenged by the ongoing, historic drought conditions. MID canceled the irrigation season in 2015 for the first time since establishment of diversions from the Merced River due to the lack of surface water availability, with the exception of a short, emergency irrigation run in July consisting of a 15,000 AF diversion.

As a conjunctive use District, MID surface water reliability has historically been high. With robust surface water deliveries during years of adequate surface water supply, MID has been able to count on its conjunctive groundwater well field to supplement its surface water supply during dry year periods. With the exception of several drought periods, which are inevitable over a long period of record, MID's historic practices have ensured its growers a robust water supply. Nevertheless, MID is concerned about its future water supply reliability. MID's primary concerns include: 1) the inability to continue to conjunctively manage its local resources due to ongoing regulatory actions by the SWRCB that threaten MID with the loss of significant amounts of surface water; and 2) the declining health of the Merced Groundwater Basin; and 3) MID growers exclusively dependent on private groundwater pumping returning to surface water deliveries due to the condition of the basin.

Currently MID experiences water supply shortages in about 20-percent of the years. Based on proposal by the SWRCB that threaten MID with a significant loss of surface water, this shortage will increase to a shortage once every two years, or 50-percent of years. As can be expected, MID is actively engaging with the SWRCB to understand the justification for such actions and find alternatives that will not impact the region in such a significant manner.

The Merced Groundwater Basin has just been declared a Critically Overdrafted Basin by the state for purposes of SGMA. Although the basins condition has been ongoing for some time, continued out-of-District agricultural development and its related groundwater extraction has put a strain on it. Groundwater pumping from the confined aquifer along the San Joaquin River in the Chowchilla Groundwater Basin has resulted in subsidence, particularly southwest of the District. As a result, overall effective groundwater capacity of MID existing wells during the typical dry year irrigation season is currently approximately 60,000 AF, versus 190,000 AF in 1977. Additionally, the saline sink under the San Joaquin River is migrating easterly into the agricultural and urban area, impacting lands in the southwestern portion of the District. MID's growers converting to low volume, high efficiency irrigation systems has significantly reduced deep percolation, adding to the strain.

There are around 30,000 acres of land within the District that solely utilize private groundwater wells for irrigation. These are expected to convert to surface water due to deteriorating groundwater quality and/or concerns regarding dropping groundwater levels and the health of the aquifer.

~End of Section~

Cressey Recharge Basin

SECTION 6: CLIMATE CHANGE (§10826 (c))

Climate change is a pervasive global phenomenon, but the changes in climatic conditions and their impacts in the regional level are varied. Changes in climate can affect water supplies through modifications in the timing, amount, and form of precipitation, as well as water demands and the quality of surface runoff. These changes can affect all elements of water supply systems, from watersheds to reservoirs, conveyance systems, and groundwater basins.

Planning for and adapting to anticipated changes in climate will be essential to ensuring water supply reliability for all users and to protect sensitive infrastructure against more frequent and extreme precipitation events. While various models disagree on the outcome, dryer or wetter, of climate change in a particular region, they all agree that the extreme events in either or wet scenarios will be more of the norm. This climate change section will address the impacts of those changes with regard to water resource management, assess the vulnerability of the region to anticipated climate change impacts, and provide responses and recommended adaptation strategies to mitigate the negative effects.

6.1 Statewide Historical Climatic Trends and Projections

Indications of climate change have been observed over the last several decades throughout California. Statewide average temperatures have increased by about 1.7ºF from 1895 to 2011, with the greatest warming in the Sierra Nevada (Moser et al. 2012). Although the State's weather has followed the expected pattern of a largely Mediterranean climate throughout the past century, no consistent trend in the overall amount of precipitation has been detected, except that a larger proportion of total precipitation is falling as rain instead of snow (Moser et al. 2012).

Even though California's average temperature has increased by 1ºF in the last one hundred years, trends are not uniform across the state. The Central Valley has actually experienced a slight cooling trend in the summer, likely due to an increase in irrigation (CEC 2008). Higher elevations have experienced the highest temperature increases (DWR 2008). Many of the state's rivers have seen increases in peak flows in the last 50 years (DWR 2008).

While historical trends in precipitation do not show a statistically significant change in average precipitation over the last century (DWR 2006), regional precipitation data show a trend of increasing annual precipitation in Northern California (DWR 2006) and decreasing annual precipitation throughout Southern California over the last 30 years (DWR 2008). A key change in precipitation patterns has been more winter precipitation falling as rain instead of snow (CNRA 2012), leading to increased streamflow in the winter and decreased streamflow in the spring and summer, when water demands are the greatest. This increased streamflow variability could lead to increased risks of flooding, levee failure, saline water intrusion and flood-or-drought-induced habitat destruction.

Multiple models have been developed and run to evaluate global and regional climate change impacts. Global Climate Models (GCMs) project that in the first 30 years of the 21st century, overall summertime temperatures in California will increase by 0.9 to 3.6ºF (CAT 2009) and average temperatures will increase by 3.6 to 10.8ºF by the end of this century (Cayan et al. 2006). Increases in temperature are not likely to be felt uniformly across California. Models generally project that warming will be greater in California in the summer than in the winter (CAT 2009) and inland areas will experience more extreme warming than coastal areas (CNRA 2009). These non-uniform warming trends are among the reasons that regional approaches to addressing climate change are important.

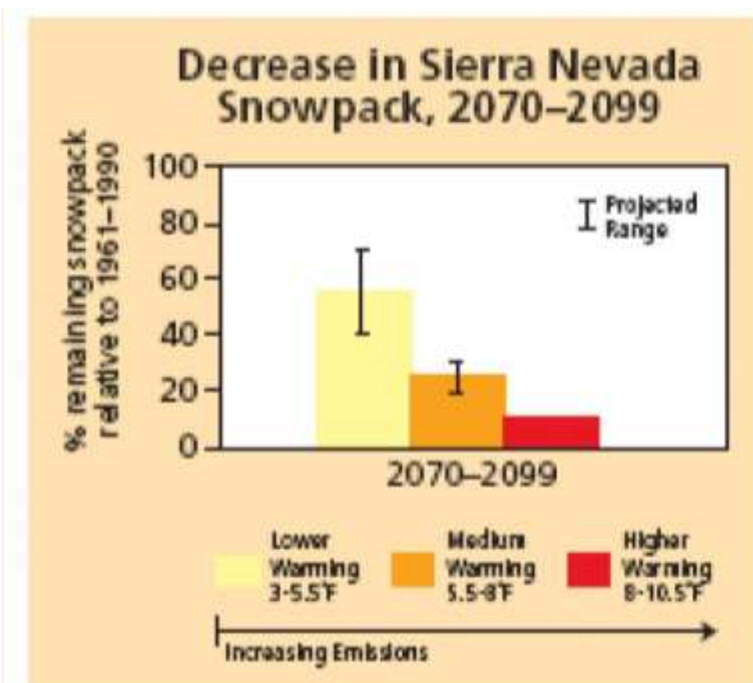
While temperature projections exhibit high levels of agreement across various models and emissions scenarios, projected changes in precipitation are more varied. Taken together, downscaled GCM results show little, if any, change in average precipitation for California before 2050 (DWR 2006), with a drying trend emerging after 2050 (BOR 2011, CCSP 2009). While little change in precipitation is projected by the GCMs as a group, individual GCM results are considerably varied. Climate projections therefore imply an increase in the uncertainty of future precipitation conditions.

6.2 Sea-level Rise, Snowpack Reduction, and Extreme Events

In the last century, the California coast has seen a sea level rise of seven inches (DWR 2008). The average April 1st snowpack in the Sierra Nevada region has decreased in the last half century (Howat and Tulaczyk 2005, CCSP 2008), and wildfires are becoming more frequent, longer, and more widespread (CCSP 2008).

As the climate warms, the Sierra Nevada's snowpack (a primary storage mechanism for California's water supply) is anticipated to continue to shrink. Based on simulations conducted to date, Sierra Nevada snowpack is projected to shrink by 30 percent between 2070 and 2099, with drier, higher warming scenarios putting that number as high as 80 percent (Kahrl and Roland-Holst 2008). Additionally, extreme events are expected to become more frequent, including wildfires, floods, droughts, and heat waves. In contrast, freezing spells are expected to decrease in frequency over most of California (CNRA 2009). While GCM projections may indicate little, if any, change in average precipitation moving into the future, extreme precipitation events are expected to become more commonplace (CBO 2009). The combination of drier and warmer weather compounds expected impacts on water supplies and ecosystems in the Southwestern United States (CCSP 2009) with wildfires expected to continue to increase in both frequency and severity (CCSP 2009).

Figure 6-1: Projected Snowpack Changes in the Sierra Nevada



Source: Hopmans et al. 2008

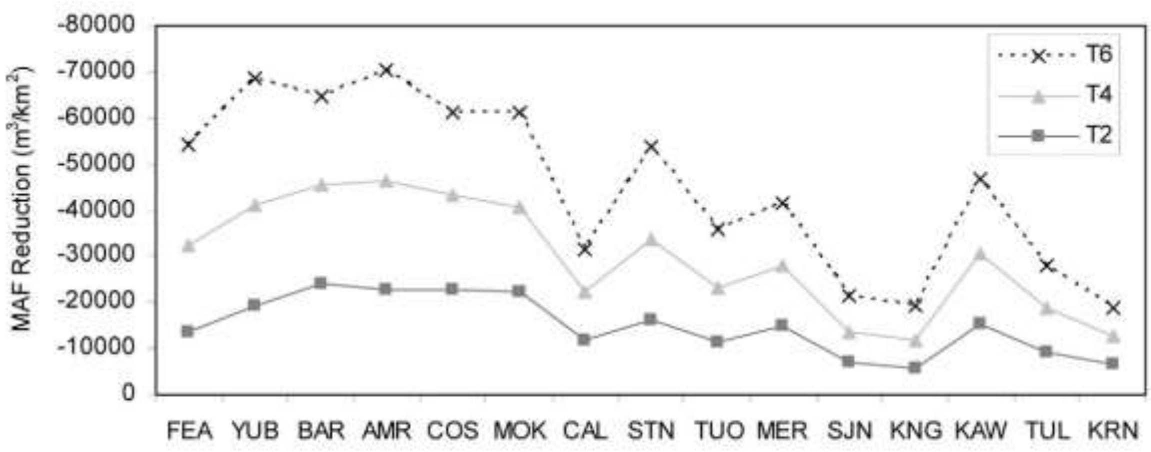
6.3 Regional Climate Change Projections and Impacts

The MID lies within the San Joaquin River Hydrologic Region and contains the San Joaquin River, Merced River, Bear Creek and Owens Creek. In general, regional climate change modeling simulations project temperature increases throughout California, with consistent spatial patterns. Anticipated temperature increases are expected to be less extreme along the southwest coast, with increasing warming to the north and northeast. There is significant uncertainty associated with future precipitation patterns and water supply projections Statewide.

In general, changes in precipitation correlate with changes in water supply, with decreased precipitation correlating to decreased stream flows and decreased groundwater recharge. A study conducted by Null et al. of the University of California, Davis Center for Watershed Sciences, published in 2010, evaluated the hydrologic response and watershed sensitivity to climate change for the Sierra Nevada watersheds, including that of the Merced River. This study used a climate-forced rainfall-runoff model to explicitly simulate intra-basin hydrologic dynamics and understand localized sensitivity to climate warming. Using the Stockholm Environmental Institute's Water Evaluation and Planning System (WEAP21), the researches simulated anticipated 2ºC, 4ºC and 6ºC temperature increases and evaluated changes from baseline for three key parameters – mean annual flow, centroid timing, and low flow duration – to highlight relative differential responses across the Sierra Nevada watersheds and in relation to water resource development (water supply, hydropower and mountain meadow habitat, respectively).

Modeled changes to climate warming in the Merced River watershed resulted in reductions in mean annual flow (MAF). Specifically, there were approximately 30 TAF (3 percent), 60 TAF (6 percent) and 80 TAF (8 percent) decreases in mean annual flow on the Merced River based on an average annual natural flow of approximately 1M AF resulting from 2ºC, 4ºC and 6ºC increases in air temperature, respectively. Relative to other Sierra watersheds, the Merced River experienced a moderate change in MAF due to climate change and was therefore considered to be less vulnerable to climate warming based on total water stored and changes in MAF than more northern watersheds (such as the American, Yuba, Bear, Mokelumne and Cosumnes Rivers).

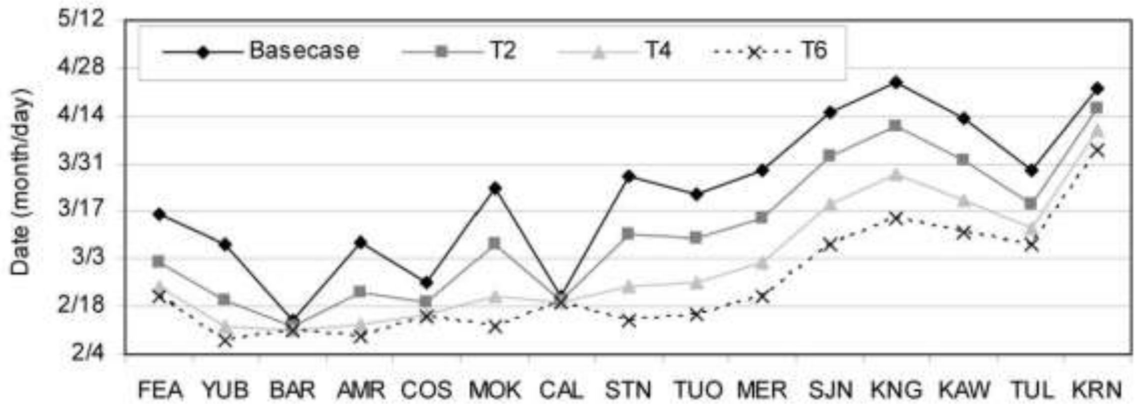
Figure 6-2: Reduction in Mean Annual Flow from Basecase by Watershed



Notes: MER – Merced River watershed;
Source: Null et al. 2010

The modeling also showed that runoff centroid timing (CT) was 2 weeks, 4 weeks, and 6 weeks earlier given the respective 2ºC, 4ºC and 6ºC increases in air temperature. Change in seasonal runoff timing may affect flood protection, water storage and deliveries. Using online hydropower capacity as a measure of impact, the study identified watersheds vulnerable to CT shifts as they rely on hydropower generation and may face substantial changes in runoff timing with climate warming.

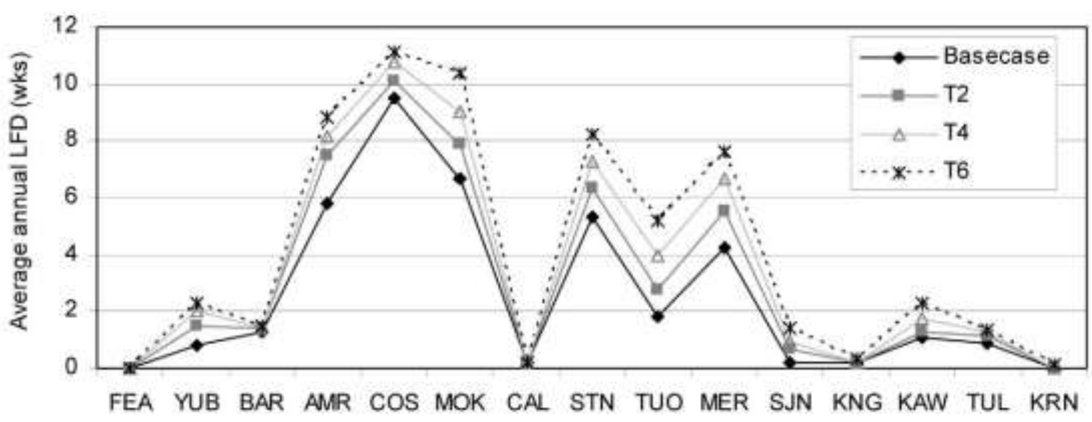
Figure 6-3: Average Annual Centroid Timing by Watershed



Notes: MER – Merced River watershed
Source: Null et al. 2010

Finally, the study evaluated the average low flow duration (LFD) for the Sierra Nevada watersheds relative to climate change. For the Merced River, average low flow duration lasted 2, 3 and 4 weeks longer for the 2ºC, 4ºC and 6ºC increases in air temperature, respectively. Merced River was considered vulnerable to LFD. Along with Yosemite and its meadows upstream, the Merced River could experience habitat loss as a result of climate change.

Figure 6-4: Average Annual Low Flow Duration by Watershed



Notes: MER – Merced River watershed
Source: Null et al. 2010

Water Resource Vulnerability

Customers who purchase their surface water supplies from MID are the primary agricultural water users in the Merced River region. Water supplies include both groundwater and surface water, with groundwater coming from the Merced (predominantly), Turlock and Chowchilla Subbasins of the San Joaquin Valley Groundwater Basin and surface water being diverted primarily from the Merced, Chowchilla, and San Joaquin Rivers. Declining Sierra Nevada snowpack, earlier runoff, and reduced spring and summer stream flows will likely affect surface water supplies and shift reliance to groundwater resources, which are already overdrafted in many places. This will, in turn, affect critical natural resource issues in the region.

Other anticipated regional impacts resulting from climate change (increased air temperatures and variable precipitation) include changes to water quality; increased flooding, wildfires and heat waves. Earlier springtime runoff will increase the risk of winter flooding as capturing earlier runoff to compensate for future reductions in snowpack would take up a large fraction of the available flood protection space, forcing a choice between winter flood prevention and maintaining water storage for summer and fall dry-period use.

The identified vulnerabilities for the Merced region which are pertinent to the MID are summarized in Table 6-1 and further described in the following sections.

Table 6-1
Merced Region Vulnerabilities

Vulnerability	**Description**
Agricultural Water Demand	Vulnerable to increased agricultural demands due to increased temperatures and evapotranspiration rates, and more frequent/severe droughts.
Water Supply and Quality	Vulnerable to decreased snowpack in the Sierra Nevada, shifts in timing of seasonal runoff, increased demands exacerbating groundwater overdraft, degraded surface and groundwater quality resulting from lower flows, exaggerated overdraft conditions, a reduction of meadows which can provide contaminant reduction, and more frequent/severe droughts and storm events increasing turbidity in surface supplies.
Flood Management/Disaster	More severe/flashier storm events and earlier springtime runoff leading to increased flooding, and a reduction of meadows which help reduce floods in the winter. Less opportunities to capture for recharge.

6.4 Agricultural Water Demand

In general, irrigation water demand varies based on crops and climatic conditions, and may or may not increase under future climate change conditions. Groundwater pumping is anticipated to increase as more irrigators and agricultural water users turn to groundwater to meet crop water requirements and farming needs (depending on surface water availability). Groundwater salinity increases with decreasing precipitation because less water is available to recharge the groundwater as a result of flashier and more variable precipitation events (Schoups et al. 2005). The effects of increased air temperatures on agriculture will include faster plant development, shorter growing seasons, changes to reference evapotranspiration (ET) and possible heat stress for some crops. In addition, fruit crops are more climate-sensitive than other crop types and may require additional water as the climate warms. Therefore, more water may be necessary to maintain yield and quality in future years of apricot or peach crops, for example, in the Merced region.

If more water is required to maintain yield, and combined with potentially reduced supplies, the agricultural community may respond to these climate-induced changes primarily by increasing the acreage of land fallowing and retirement, augmenting crop water requirements by groundwater pumping, improving irrigation efficiency, and shifting to high-value and salt-tolerant crops (Hopmans et al. 2008). However, agricultural impacts resulting from climate changes are anticipated to be significant for the MID as Merced County ranks 5th in the state in agricultural production with a value of over $2.7 billion (Kahrl and Roland-Holst 2008).

Groundwater modeling indicated that groundwater demands are highest during dry years, likely due to the fact that groundwater is primarily used for agricultural irrigation (MAGPI 2002). The seasonal variability of water demands is projected to increase with climate change as droughts become more common and severe (DWR 2008). Other seasonal uses such as landscape irrigation demands are also expected to increase as a result of climate change (DWR 2008 and CNRA 2009).

Water Supply and Quality

The MID's water supplies include groundwater and surface water from Merced River and local creeks and drainages. Additional water storage will be required to ensure water supply reliability due to the impact of early spring runoff and reduced mean flow. Without additional storage, it will be difficult to capture and retain the extra runoff for use after April 1st without reducing the amount of flood storage space left in reserve. Both the need for empty storage for flood protection and the need for carryover storage for drought protection reflect the uncertainty about future weather conditions and the level of regional risk aversion (Hayhoe et al. 2004). Another concern is MID's water rights on the Merced River which are effective only in certain time periods.

Decreased summertime flows will likely result in increased groundwater pumping (and potential overdraft conditions) due to increased groundwater to offset surface water shortages. Additionally, rising temperatures are projected to increase the frequency of heat waves, which could also lead to increased water use and further exacerbate low flow conditions (Hayhoe et al. 2004).

Finally, climate change impacts may affect water quality in a multitude of ways.

- Water quality can be impacted by both extreme increases and decreases in precipitation. Increases in storm event severity may result in increased turbidity in surface water supplies while decreases in summertime precipitation may leave contaminants more concentrated in streamflows (DWR, 2008) as well as increased dissolved concentrations of constituents in groundwater due to decreased groundwater percolation.
- Higher water temperatures may exacerbate reservoir water quality issues associated with reduced dissolved oxygen levels and increased algal blooms (DWR, 2008).

Declining Sierra Nevada snowpack, earlier runoff and reduced spring and summer stream flows will likely affect surface water supplies and shift reliance to groundwater resources, which are already overdrafted in many places.

Groundwater Quality

The MID service area overlies three groundwater subbasins within the San Joaquin Groundwater Basin including the Merced Subbasin in entirety, and portions of the Chowchilla and Turlock Subbasins.

According to the 2008 Groundwater Management Plan (GWMP) Update (Amec 2008), groundwater elevations in the Merced Subbasin have been monitored by DWR, MID, and other entities since the 1950s. This monitoring data demonstrates that since 1980 average groundwater levels beneath the Merced Subbasin have declined approximately 36 feet, with most of this decline occurring between the end of 1980s drought in 1993 and 2014. As such, the Merced Subbasin is considered to be in a state of long-term groundwater level decline. In addition to dropping groundwater levels, the Merced Subbasin has high concentrations of total dissolved solids (TDS), generally at depths between 400 and 800 feet below the ground surface, that increase in concentration from east to west. The San Joaquin River acts as a natural saline barrier, so generally, TDS concentrations are greater on the west side of the River and less on the east side. Reduced streamflows in the River could reduce the effect of the natural barrier and allow for further migration of salinity in the groundwater basin. Additionally, climate change impacts may cause increased evapotranspiration and longer growing seasons for permanent crops, further exacerbating groundwater overdraft and high salinity levels.

Portions of the groundwater subbasins are subject to high nitrate concentrations; elevated iron and manganese concentrations; and contamination with methyl tert-butyl ether (MTBE), 1,2-dibromo-3-chloropropane (DBCP) and other contaminants; which can impact the beneficial use of groundwater. Lastly, the variation in precipitation and streamflow in the future will influence how and when the groundwater subbasins are recharged.

Surface Water Quality

The Central Valley Regional Water Quality Control Board (RWQCB) compiled the 303(d) list of impaired water bodies within the Sacramento River and San Joaquin River Basins that suffer significant water quality impairments from a variety of pollutants and must be addressed through the development of Total Maximum Daily Loads (TMDLs). The Lower Merced River (from McSwain Reservoir to the San Joaquin River) is included on this list. Irrigated agriculture has been identified as a significant anthropogenic source of both nitrate and sediment loading in surface water bodies. Additional sources of sediment loading include erosion, mining, and grazing, among others. Current climate change scenarios project lower stream flows and higher agricultural water use that would pose significant challenges in implementing the defined TMDLs and meeting water quality goals.

Lake McClure and the Merced River are supplied primarily by snowmelt from the Sierra Nevada. Changing volumes of snowfall and snowpack in the Sierra Nevada and the changing seasonal melting patterns may require changes in dam operation. As the timing of snowmelt shifts in the spring, hydroelectric power generation may also shift to accommodate enhanced flood control operations. Additionally, increasing temperatures will also increase energy demands, especially during peak demand times (DWR 2008). As previously described, the modeling completed as described in the *Hydrologic Response and Watershed Sensitivity to Climate Warming in California's Sierra Nevada*, showed that runoff centroid timing (CT) on the Merced River was 2 weeks, 4 weeks, and 6 weeks earlier given the respective 2ºC, 4ºC, and 6ºC increases in air temperature, respectively. Change in seasonal runoff timing may affect electrical generation capabilities, flood protection, water storage and deliveries. Hydropower is often generated during high demand periods, which may be compromised if facilities are forced to spill due to higher magnitude flows or to accommodate early arrival of flows (Null, et. al. 2010).

Adaptation Strategies

Global climate modeling carries a significant degree of uncertainty resulting from varying sensitivity to changes in atmospheric forces (e.g. CO_2, aerosol compounds), unpredictable human responses, and incomplete knowledge about the underlying geophysical processes of global change. Even though current scenarios encompass the "best" and "worst" cases to the greatest degree possible based on current knowledge, significant uncertainty associated with future global GHG emission levels remains, especially as timescales approach the end of the century. The historical data for calibrating GCMs is not available worldwide, and is spatially biased towards developed nations.

Therefore, considering the great deal of uncertainty associated with climate change projections, a prudent approach to addressing climate change incorporates a combination of short-term and long-term adaptation strategies. Climate adaptation includes strategies (policies, programs or other actions) that prepare the District to effectively respond to the unavoidable negative climate impacts. These strategies are also identified in the *California Water Plan* (CWP) as resource management strategies (RMSs) for water management approaches in the region. The potential issues to consider are as follow:

- Reduce Water Demand
- Improve Operational Efficiency and Transfers
- Increase Water Supply
- Improve Water Quality
- Improve Flood Management
- Other Strategies

As described in the *Climate Change Handbook for Regional Planning* (CDM 2011), the key to climate change adaptation or mitigation is to be directed at overall system resiliency, which improves a system's resilience to the uncertain conditions climate change could bring.

6.5 Reduce Water Demand

Reducing existing and future water demands can reduce pressure on water sources of limited supply and help adapt to the potential climate change impacts of less precipitation, shifting of springtime snowmelt, and overall uncertainty. Opportunities for increased water conservation and water use efficiency measures are discussed in other sections of this document. Performance metrics that could be used to measure the effectiveness of reduced water demand adaptation include average water demand reduction per year and peak water demand reduction per month (CDM 2011).

MID is already implementing many agricultural water use efficiency efforts. It has identified and is currently implementing efficient water management practices (EWMPs) as part of this Plan. Several EWMPs that include infrastructure upgrades and operational improvements reduce water demand and maintain productivity. The following are the two groupings of EWMPs that MID is considering implementing in the short-term:

- ***Infrastructure Upgrade:*** Evaporation loss from irrigation ditches and canals is a function of temperature and other climate variables. Depending on different emission scenarios, the operation of these facilities may be impacted by climate change, leading to increased water loss. One of the EWMPs is to convert irrigation canals and ditches to piping. This water conservation method prevents evaporative losses, which will only increase as temperatures rise. This approach could help the MID adapt to climate change by expanding water supplies and making existing water supplies less vulnerable to climate change impacts. Canal lining is identified as a less capital-intensive method to reduce seepage into the ground, although it does not reduce water evaporation and does reduce groundwater recharge that occurs as a result of this seepage. Canal automation can increase water supply reliability and flexibility to deliver water at the time, quantity, and duration required by the grower, and can facilitate conversion to more efficient irrigation methods such as micro-irrigation.
- ***Water Management:*** MID and its users will take advantage of new technologies and hardware to optimize management of water-related infrastructure for water conservation. Supervisory control and data acquisition (SCADA) systems enable water managers to collect data to a centralized location and operate automated canals to achieve desired water levels, pressures or flow rate, and also increase the efficiency in reservoir operation. The system in both monitoring and control capacity was commissioned in 1997 with 17 sites and has been expanded since then at the rate of around one station a year. In addition, automated control will free water system operators from manual operation and allow them to plan, coordinate system operations, and potentially reduce costs. Such systems improve communications and provide for flexible water delivery, distribution, measurement, and accounting. On-farm practices can also be improved. Furrow, basin, and border irrigation methods have been improved to ensure that watering meets crop water requirements while limiting runoff and deep percolation. Using organic or plastic mulch can reduce non-essential evaporation of applied water. Advanced irrigation systems include GIS, GPS and satellite crop and soil moisture sensing systems and can all improve overall farm water management.

Improve Operational Efficiency and Transfers

Water supply system operations need to be optimized in order to maximize efficiency. Well-maintained conveyance infrastructure improves water supply reliability and enhances regional adaptability to climate change impacts. Addressing aging infrastructure, increasing existing capacity, in-system storage and/or adding new conveyance facilities can improve existing conveyance system and operational efficiency.

As a long-term approach through system reoperation, the New Exchequer Dam may be able to adapt to less reliable water supplies and/or increased water demands by maintaining conveyance infrastructure, as well as adapting to climate change impacts on hydropower production, flooding, habitat, and water quality. The approach is to model and determine the trade-offs associated with levels of encroachment in the flood pool or reservoir operation under new, adaptive rules.

MID is currently investigating and implementing long-term or short-term water transfers. Specifically, the City of Merced and MID are working to formalize the exchange of tertiary-treated wastewater effluent from the City of Merced for surface water from MID. This will help the region adapt to climate change by providing additional climate resilient water supplies. As such, transfers can improve supply reliability when other supplies are projected to have reduced reliability due to climate change impacts.

An example of a performance metrics to quantify this strategy includes amount of new supply created through regional water transfers (CDM 2011).

Increase Water Supply

As water demands increase due to longer growing seasons, higher temperatures, and longer droughts, and the future of existing water supplies sources becomes less certain, MID will need to enhance existing water supplies to meet demands. Increasing water supply can be accomplished through the implementation of conjunctive management of surface and groundwater supplies as well as through groundwater storage, recycled water use, and increased surface water storage, as appropriate. Diversifying the region's water supply portfolio and adding drought-resistant sources is an adaptation measure that will help address increased water demands and/or decreased supply reliability. Performance metrics for measuring the effectiveness of the increased water supply could include additional supply created, amount of potable water offset, and supply reliability (CDM 2011).

Conjunctive Management and Surface and Groundwater Storage

MAGPI has been implementing the Merced Groundwater Basin Groundwater Management Plan, which promotes conjunctive surface water and groundwater management to improve the long-term sustainability of the Merced Groundwater Basin. MID as the lead agency for MAGPI's conjunctive use will continue to investigate conjunctive management to increase surface and groundwater use, improve groundwater quality, and adapt to climate change. Increased storage and conjunctive use may increase resilience to shifting runoff patterns, providing more storage for early runoff, reducing or eliminating the potential climate change impacts on flooding and hydropower production, and offsetting decreases in snowpack storage. This strategy is valuable as weather patterns change in frequency and timing and more extreme events occur. MAGPI is in the process of calibration of an integrated water resources (surface water/groundwater) model with funding from the State that will provide MAGPI the modeling tools to better manage the basin conjunctively between surface water and groundwater supplies. The integrated model is capable of simulating the interactions between surface water and groundwater to determine the impacts of surface water supplies on groundwater supplies due to the effects of climate change. It will also help forecasting impact on groundwater in the different useful aquifers as the result of existing and forecasted groundwater extraction rates.

Developing a project to provide additional local surface water storage is a possible adaptation strategy for climate change impacts on water supply and associated reliability. Storage provides a way of adjusting a water system to altered peak streamflow timing resulting from earlier snowpack melting. Additional storage capacity could also help to adapt to the anticipated increased precipitation variability. Increased surface storage could allow water managers to make real-time decisions that are not available otherwise. It would also facilitate water transfers between basins from upstream reservoirs to receiving regions that have additional storage for the transferred water. Added storage provides greater flexibility for capturing surface water runoff, managing supplies to meet seasonal water demands, helping manage floods from extreme storm events, and adapt to extreme weather conditions such as droughts.

As part of its effort to increase surface water storage, MID is pursuing increasing carryover storage in New Exchequer Reservoir. This will be accomplished by raising the current New Exchequer spillway elevation by about 8 feet.

In addition, rehabilitation and possible enlargement of existing dams and infrastructure will potentially improve the lack of reservoir storage capacity. The Merced Integrated Regional Water Resources Management Plan (IRWMP) has included various existing reservoir enlargement projects as well as new off-stream regulating reservoir as proposed by MID and others as potential projects to augment the water supply shortage issue.

Finally, implementing conjunctive management and groundwater storage can provide benefits similar to additional surface storage, in addition to increased water management flexibility while also reducing groundwater overdraft. There is the potential to bank water, flood flows, runoff, recycled water, and/or desalinated water for dry seasons in groundwater basins. Conjunctive management is highly dependent on how well surface water and groundwater are managed as a single source to adapt to the climate system.

Recycled Water Use

The California Recycled Water Policy, developed by the State Water Resource Control Board in 2009, includes a goal of substituting as much recycled water for potable water as possible by the year 2030. Recycled water is a sustainable, climate resilient local water resource that could significantly help to meet water management goals and objectives, and assist in meeting the seasonal water demands of agriculture. Water recycling also provides a local supply that generally uses less energy than other water supplies, helping to mitigate climate change impacts through associated GHG emissions. Beside to what is being negotiated between the City of Merced and MID as mentioned earlier, recycled water used for agricultural purposes and urban landscape irrigation, and expanded use will be encouraged and explored as opportunities arise.

Improve Water Quality

Groundwater remediation, matching water quality to use, pollution prevention, salt and salinity management, and urban runoff management can help improve water quality for all uses. These strategies may help MID to adapt water quality impacts from climate change on the district level. They may also contribute to providing additional supplies; for example, storm water capture and reuse would reduce pollution and also provide a seasonal source of irrigation water for urban landscaping or groundwater recharge. Water quality performance metrics for this RMS could include stream temperature, dissolved oxygen content, and pollutant concentrations (CDM 2011).

Pollution Prevention

In recent years, as point sources of pollution have become regulated and controlled, "non-point source" (NPS) pollution has become a primary concern for water managers. NPS pollution is generated from land use activities associated with agricultural development, forestry practices, animal grazing, uncontrolled urban runoff from development activities, discharges from marinas and recreational boating activities, and other land uses that contribute pollution to adjacent surface and groundwater sources. The East San Joaquin Water Quality Coalition (ESJWQC), which MID is a member of, will continue to assess the level of surface water quality in the region and to monitor any changes that could occur due to the negatives effects of climate change.

More severe flooding patterns and frequencies due to climate changes will invariably contribute to higher debris flows and sedimentation loads. There are several multi-purpose storm water capture, recharge, and reuse projects that have been proposed in the Merced IRWMP by other agencies and MID to address this issue. These detention storage basin projects allow sediments and potential contaminants to settle out before entering the distribution system for usage. Protecting water supply sources will help to ensure that long-term sustainability of those supplies.

Salt and Salinity Management

Accumulation of salts in soil can impair crop productivity, making salinity management a critical concern for the District's highly productive agricultural industry. Several potential benefits of establishing or improving salt and salinity management include protecting water resources and improving water supplies, securing, maintaining, expanding, and recovering usable water supplies, and avoiding future significant costs of treating water supplies and remediating soils. Salt and salinity management strategies identified by the *California Water Plan Update 2009* include:

- Developing a regional salinity management plan, and interim and long-term salt storage, salt collection, and salt disposal management projects;
- Monitoring to identify salinity sources, quantifying the level of threat, prioritizing necessary mitigation action, and working collaboratively with entities and authorities to take appropriate actions;
- Reviewing existing policies to address salt management needs and ensure consistency with long-term sustainability; and
- Collaborating with other interest groups to optimize resources and effectiveness;
- Identifying environmentally acceptable and economically feasible methods for closing the loop on salt.

As part of the Merced IRWM planning process, MID and the region is developing information to support development of a salt and nutrient management plan. This will identify specific salt and salinity challenges within the region and strategies to help adapt to climate change by mitigating potential salinity increases associated with climate change.

Forest Management

Although MID does not have authority to manage the upland forested areas that drain to the Merced River watershed, protection of those lands is a vested interest of MID for ensuring high quality and quantity surface runoff supplies. Proper forest management would improve water quality and quantity, help reduce wildfires, and improve ecosystem and habitat within the watershed. The University of California, Merced staff researchers and MID, through an IRWM grant, are currently collaborating in forest management studies that will hopefully improving water yield originating from the high mountain forested area.

MID also received a Flood-Coordinated Operation (FC-O) grant from the Department of Water Resources to install additional stream gages and precipitation stations upstream and within the boundary of the District to be used to better manage and forecast floods and to establish and confirm climate trends and evaluate hydroclimatic and geologic conditions. Another objective of the grant program is to improve flood forecasting by using forecasting tools such as a physically- based simulation model to operate the reservoir in real-time. With the help of a good forecasting tool, the impacts of climate change on river runoff and reservoir operations may be reduced. Water quality and sediment monitoring stations would allow quantification of the effects of climate change as well as forest management activities on surface water quality (CDM 2011).

Other Strategies

Additional conservation and demand reduction measures, such as crop idling, irrigated land retirement, and rain-fed agriculture could be implemented as adaptive management strategies.

~End of Section~

New Exchequer Dam

February 2014
Sierra Nevada Snow Survey

SECTION 7. EFFICIENT WATER MANAGEMENT PRACTICES (EWMPs) (§10608.48)

The purpose of this section is to identify EWMPs that will accomplish improved and more efficient water management.

Under the authority included under the California Water Code §10608.48(i)(1), the Department of Water Resources is required to adopt regulations that provide for a range of options that agricultural water suppliers may use or implement to comply with the measurement requirements in paragraph (1) of subdivision (b) of §10608.48. For reference, §10608.48(b) of the California Water Code states that:

> *Agricultural water suppliers shall implement all of the following critical efficient management practices:*
>
> *a. Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement paragraph b.*
>
> *b. Adopt a pricing structure for water customers based at least in part on quantity delivered.*

7.1 Critical Efficient Water Management Practices (EWMPs) (§10608.48 (b))

1. Measure the volume of water delivered to customer with sufficient accuracy ((**§**10608.48(b)(1))

   MID has been measuring the volume of water delivered to customers since 1993, when it adopted a volumetric rate for its water sales and charges for water by the acre-foot, in increments of 0.1 AF. With the exception of a few community laterals or private pipeline networks, all MID delivery points are measured. See Section 3.6 and Appendix F, Water Measurement Documentation and Reporting, for a more detailed discussion of the various turnout types and their associated water measurement attributes as they relate to the Agricultural Water Measurement Regulation (Regulation).

   a. Collection of Water Measurement Data:

      i. MID uses a state of the art, SQL-based database application to manage its water measurement data for growers, including all water ordering, delivery and billing information.

      ii. Growers are required to place a water order for planned irrigations. MID growers can place a water order by speaking with a Customer Service Representative in person or on the phone, facsimile, an automated phone water ordering system, or through the mercedid.org web site. A grower would identify its Account Number (field), desired flow rate, time of start of delivery and duration, upon which the grower is provided a confirmation number for the request. MID Distribution System Operator (DSO) receives the request on a portable computer and coordinates the delivery with the grower.

      iii. The DSO collects flow related data such as meter reads or for meter-gates, delivery start time, flow rate, delivery stop time, as well as any flow changes occurring throughout the delivery.

   b. Frequency of Measurements:

Metered turnouts are typically read once per week. The DSO enters the current meter read into the operations database, which subtracts the previous meter read and calculates AF for billing purposes.

Meter-gate turnouts are typically measured once during irrigation and as needed depending on changing conditions. The DSO enters the instantaneous flow rate, start time and end time, as well as the time and value of any flow changes, into the operations database, which performs the acre-foot calculation for billing purposes.

c. Methods for Determining Irrigated Acres

In non-drought years, MID typically requires that all MID customers submit an irrigation application prior to the start of the irrigation season. Application information includes which parcels will request MID water, including acreage, cropping, and method of irrigation. See Figure 7.1, Application for Irrigation Water. Although this is good for planning purposes, MID also collects record data by tracking each water delivery throughout the irrigation season, including parcels and associated acreage water is delivered to, volume and flow rates delivered and cropping patterns, among other things.

Figure 7.1: Application for Irrigation Water

MERCED IRRIGATION DISTRICT
www.mercedid.org

Application for Irrigation Water

Mailing Address: P.O. Box 2288
Merced, CA 95344-0288
Main Office: (209) 722-2720
Automated: (800) 750-2720
Main Office: 744 W. 20th Street,
Merced, CA 95340

Customer Information

Joe Farmer

99 Farmland Lane
Merced, CA 95340

Customer #: 999999
Contact Phone: (209) 999-9999

Water Account Information

Please verify information in each column below. If corrections are needed, line through incorrect information and write-in correct updates. If column is blank, please write-in information accordingly.

IMPORTANT
If you have a tenant leasing your property and their name is not listed below in column 12, you will need to complete a new Landowner Tenant Agreement (LTA) and submit it to MID Customer Service. LTAs should be mailed to MID Customer Service at the address above or faxed to (209) 722-1457.

Water Account (1)	Section/Facility (2)	Total Irrigated Acres (3)	1st Crop (change to "Fallow" if using transfer water during curtailment year) (4)	Irrigation System (Sprinkler, drip, micro, flood, etc) (5)	Parcel APN (6)	Parcel Acres (7)	Requested AF (8)	Private Well Crop (9)	Private Well Acres (10)	Farming / Leasing (11)	Tenant Information on File (12)
F####	Fairfield B Side / Hartley Lateral	11.70	Walnuts	Sprinkler	999999999A	11.70				Farming	Joe Farmer

Notes and Signature

1. This application must be submitted prior to ordering/receiving irrigation water.
2. Applicant shall abide by all Merced Irrigation District (District) Rules and Regulations Governing the Distribution of Water (Rules and Regulations) as a condition to water service. Applicant's signature below confirms that Applicant has received and read the Rules and Regulations, or that Applicant has waived reading same. If Applicant has not received a copy of the Rules and Regulations, Applicant is aware they are available from the Customer Service Department and is responsible for obtaining a copy and abiding by same.
3. Applicant, by the filing of the Application, hereby assumes the responsibility for the proper disposition of drainage water resulting from the use of water applied for, and agrees to hold the District harmless from any responsibility arising out of any damage or claim of damage from surface or subsurface drainage resulting from the user of the water applied.
4. Water furnished by the District under this Application is not treated to make it safe for drinking or stock watering purposes.
5. The terms of the Application and all Rules and Regulations shall apply to any subsequent verbal request for water which may be accepted by the District within this irrigation season.

Signature of Applicant - #999999 - Joe Farmer

Date

d. Quality Control and Quality Assurances Procedures:

   i. MID DSOs are responsible for the delivery measurement at every gate in the District.

   ii. A Senior Distribution System Operator checks the values and approves the final posting.

   iii. The operations database tracks allocations when applicable and alerts the DSO as the grower approaches its maximum allotted volume.

e. Measurement with compliance with §597.3(b), as outlined in Section §597.3(b)(2) and Section §597.4(b)(2) and Frequency.

   i. See Appendix F, Water Measurement Documentation and Reporting, for a detailed discussion of MID's compliance activities as they relate to the Agricultural Water Measurement Regulation.

2. Volumetric Pricing (§10608.48(b)(2))

   MID adopted a volumetric rate for its water sales in 1993. MID sells water by the acre-foot, in increments of 0.1 AF. By this long standing adoption, MID meets related SB X7-7 requirements. Please refer to Section 3.7 for a detailed discussion regarding MID's volumetric pricing program.

3. Table 7-1 summarizes the status of MID's Critical and Conditional Efficient Water Management Practices

Table 7.1 MID Efficient Water Management Practices

Critical EWMPS

Water Code Reference No.	EWMP	Implementation Status	Implementation	Planned Activities
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy	Implementing	See Section 3.6 and Appendix F, Water Measurement Documentation and Reporting	See Appendix F, Water Measurement Documentation and Reporting, for planned activities.
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Implementing	MID Board adopts rate per AF for various uses in-District, including surface water deliveries to ag, urban, out-of-District, and supplemental water made available through conjunctive groundwater pumping.	Continue long standing volumetric pricing. Periodically review long term O&M and capital needs and ensure pricing is sufficient to properly maintain system, taking into account other revenue sources.

Table 7.1 MID Efficient Water Management Practices ***Conditional EWMPS*** ***(continued)***				
Water Code Reference No.	**EWMP**	**Implementation Status**	**Implementation**	**Planned Activities**
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 applicable	Lands with exceptional high water levels or whose irrigation contributes to significant problem including drainage does not exist within MID.	Not Applicable
10608.48.c (2)	Facilitate use of available recycled water.	Implementing	MID is in discussion with the City of Merced regarding using portion of the City's waste water effluent. Other effluent sources are not available, either because water is already committed to a third party or it is not tertiary treated.	Culminate discussions with the City of Merced.
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	• MID Water Conservation Program • Technicians available to help growers • Educational workshops, newsletters and MID website. • Make presentations at the Farm Bureau, UC extension and other similar local activities • Hold town hall meetings to discuss means to increase on-farm improvements	Continue to implement

Table 7.1 MID Efficient Water Management Practices

Conditional EWMPS
(continued)

Water Code Reference No.	EWMP	Implementation Status	Implementation	Planned Activities
10608.48.c (4)	Implement an incentive pricing structure that promotes one or more of the following goals identified in the CWC	Implementing	• In 2012, MID Board raised its water price for agricultural deliveries. • In 2014 MID Board raised its water rate again after completion of a Proposition 218 process • Conjunctive Use/Increase Groundwater Recharge - Water price is based on Cost of Service. • Recharge- reasonable in-basin out-of-District water rate in years of available surface water supply.	The Water Resources Management Plan will address rates.
10608.48.c (5)	Expand line or pipe distribution systems, and construct regulating reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	• MID regularly adopts projects for pipelines and/or canal lining under its CIP or extra ordinary maintenance budget. • Pipelined approximately 1 mile of open laterals since 2012. • Capital projects over the last 3 years have combined to reduce or eliminate operational spills and seepage a total of 10,250 AF annually • District has a combined total of 3,590 AF in regulating reservoir space. • A number of regulating basins and added two more basins for a total of 300 AF since 2012. • MID lined 25,000 LF of canals since 2012	MID's Water Resources Management Plan (WRMP) will include a system evaluation and modernization plan, including regulating reservoirs where applicable, and will also address funding and prioritization.

Table 7.1 MID Efficient Water Management Practices

Conditional EWMPS
(continued)

Water Code Reference No.	EWMP	Implementation Status	Implementation	Planned Activities
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implemented	• SCADA: Completed first installations in 1997 with 17 stations, and expanded since to 56 stations. • Around the clock water order service with operators, voice activated system, facsimile, or the web. • Custom delivery = each irrigation could differ in flow rate, duration, and start of irrigation. • Limited on-demand, constant flow, and arranged on-demand irrigation service. • Growers can review delivered water online. • Flexible distribution system.	Continue improving flexibility to water ordering. Add SCADA stations in 2016, continue adding stations per the WRMP. Continue improving MID GIS system assessments and operations

Table 7.1 MID Efficient Water Management Practices ***Conditional EWMPS*** ***(continued)***				
Water Code Reference No.	**EWMP**	**Implementation Status**	**Implementation**	**Planned Activities**
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	• MID completed projects automating canals to effectively intercept flows from up-gradient laterals that otherwise would have otherwise ended in a natural stream. • Constructed canals and pipelines to move operational discharges to areas of water commitment, such as the Casebeer Extension to Merced National Wildlife Refuge. • Pipelined laterals and backed up flows away from traditional spill such as the recently completed Garibaldi Lateral Spill to Merced River completed in 2012.	The District's WRMP (previously discussed) includes a long range capital improvement plan focused on modernization of District facilities, including: 1. Construct approximately a dozen new regulating reservoirs. 2. Change existing control directions at key points. 3. Improve water level control along the main canal "superhighways." 4. Improve flow measurement and control at key points. 5. Create new pumpback, intertie, and diversion pipelines. 6. Overall, the modernization component of the long range capital improvement program is estimated to cost over $40M. Each modernization component will contribute to minimizing operational spill and spill recovery.
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	• Completed studies regarding expanding groundwater fields. Study recommendation did not recommend well construction. • MID Groundwater Conservation Incentive Program, growers revert to groundwater in years of surface water shortage. • In-Lieu Recharge: Reduce base line pumping by management actions, Highlands Pilot Project, Low Head Boosters replacing	MID's conjunctive use program is extensive and leading-edge. MID will continue to expand all components of its conjunctive use program. • MID is in the process of completing a project by 2016 to provide surface water to 800 acres of highlands area. The area will still be served by 8 groundwater wells in years of surface water shortages. • MID completed a study for

			deep wells, increased system flexibility to compete with groundwater in non-dry years. • Construct Recharge basins which are left idle during droughts.	application of surface water in wet years of District lands and in the basin. MID will educate growers on the virtue of dual irrigation systems, for use in wet years (flood, furrow) and other years (drip) • Continue pursuing projects identified in the Merced IRWMP
10608.48.c (9)	Automate canal control structures	Implementing	• Completed 85 projects automating control structures since 2002. • MID installed 17 SCADA sites in 1997, which have since expanded to a total of 56 sites. • Tabled topped and pipelined canals	Will continue to expand its control structure automation. Projects will be identified under the Water Resources Management Plan.
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Implementing	• MID senior Distribution System Operators are trained to perform pump tests. • Performed more than 500 pump tests since 2002. • Staff provides information and education to District's growers.	Will continue to perform and promote pump testing.
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	Hicham Eltal appointed as WC Coordinator effective- December 15, 1998.	MID is training staff to better serve growers interaction with the District distribution system to optimize designs

Table 7.1 MID Efficient Water Management Practices ***Conditional EWMPS*** ***(continued)***				
Water Code Reference No.	**EWMP**	**Implementation Status**	**Implementation**	**Planned Activities**
10608.48.c (12)	Provide for the availability of water management services to water users.	Implementing	• MID operates and maintains a CIMIS station with a link on its website • MID has a full-time Engineering Technician dedicated to support growers. • Educate growers on how to order varied water orders to better manage their operation. • Provides growers with monthly bills. • On-line web page for growers to review their existing deliveries over all their individual fields and plan to stay within the water allocation for the season.	Will continue to pursue
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	MID owns its own storage at Lake McClure. Since the creation of the Independent System Operator (ISO), MID had to make diversions forecasts 48 hours in advance which tested all MID's regulating systems. For the 2013 irrigation season, MID has dropped that to 24 hours through coordination with the Hydro personnel. MID has its own groundwater wells that are always on standby. The Water Operations Superintendent authorizes the DSOs the wells to be operated in a given period. DSOs are free to engage the authorized wells for the highest efficiency.	MID will continue to increase its coordination will all parties towards maximum system flexibility
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	The District Engineering Department and the Pump Department work on continually upgrading wells and boosters through system evaluations and pump tests, see Table 5.2.	The District plans to install more than 150 motor savers within the next 5 years. • Currently installing VFD's on certain pumps. • The District plans

				to upgrade Booster Station #2 • The timing and financing of the upgrade will be addressed through the proposed Water Resources Management Plan • The District plans to install motor savers on all its wells and boosters in addition to a major upgrade to Booster Station #2 facilities which has a maximum combined capacity of 270 cfs.

7.2 Conditional Applicable Efficient Water Management Practices(§10608.48 (c))

Table 7.2 identifies current conditional applied EWMPs and their experienced benefits. A discussion of each follows the table.

Table 7.2
Current Efficient Water Management Efforts

Conditional EWMP	(Check if results were experienced)						
Water Management Plan	Less Applied Water (AF)	Inc. System Eff.	Better Water Qual.	Inc. Yield	Inc. Crop Qual	Reduce Ops Costs	Other
EWMP 1 -Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Applicable						
EWMP 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.	Pending						
EWMP 3- Facilitate financing of capital improvements for on-farm irrigation systems	X			X	X	X	Less Weeds
EWMP 4 -Implement an incentive pricing structure that promotes one or more of the goals identified in the CWC	X						
EWMP 5- Expand line or pipe distribution systems, and construct regulating reservoirs increasing distribution system flexibility and capacity, decrease maintenance and reduce seepage		X	X	X	X	X	Saves Energy
EWMP 6 - Increase flexibility in water ordering by, and delivery to, water customers within operational limits	X			X	X		N/A
EWMP 7 - Construct and operate supplier spill and tailwater recovery systems		X	X				
EWMP 8 -Increase planned conjunctive use of surface water and groundwater within the supplier service area							Inc. Resource Reliability
EWMP 9 -Automate canal control structures		X	X	X		X	
EWMP 10 Facilitate or promote customer pump testing and evaluation	X						
EWMP 11 - Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	X	X	X	X	X	X	
EWMP 12 - Provide for the availability of water management services to water users.	X	X		X	X	X	
EWMP 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.	X	X	X				
EWMP 14 - Evaluate and improve the efficiencies of the supplier's pumps.		X				X	

EWMP 1. Facilitate Alternative Land Use (§10608.48(c)(1))

Response: Not Technically Feasible.

Discussion: Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the District boundaries, nor within the District Sphere of Influence. Furthermore, MID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring.

Irrigated farming at MID is the primary land use. The District's water management policies allow farmers flexibility in selecting crops to maximize the benefits of this land use. Groundwater recharge from deep percolation contributes to the water supplies used by urban areas and low density rural human dwellings and, thereby, supports existing urban land uses.

Farmers chose other crop as alternatives to rice, a high water demand crop. Rice lands in the MID exceeded 12,000 acres by the early 1980s. The area has dropped to less than 2,000 acres as alkali grounds were leached over the life of the diversion project since the late 1880s. The observed reeducation was converted to other less water demanding crops. It is expected that the rice planted areas will continue to decrease, afforded through MID flexible service term. Beyond the remaining estimated 2,000 acres, this EWMP is technically not feasible.

EWMP 2. Facilitate Use of Available Recycled Water (§10608.48(c)(2))

Response: Implementing

Discussion: Please refer to Section 5.3 Water Accounting detailed discussion regarding MID's facilitation of the use of available recycled water.

EWMP 3. Facilitate Financial Assistance (on-farm capital improvements) (§10608.48(c)(3))

Response: Implementing

Discussion: MID has provided various financing programs over the years to support its conjunctive management objectives. These programs have included MID's Groundwater Conservation Incentive Program, where growers receive up to $200 per acre to apply towards on farm improvements needed to take surface water from the MID during years of available surface water and utilize their groundwater wells during years of surface water shortages. Funds could be applied by growers to filters, pumps, structures, valves and all other means needed to facilitate using surface water. The program proved most beneficial for users utilizing flood irrigation from groundwater wells. The program has assisted nearly 6,000 acres since its inception in 1997.

The District also assigns various engineers and technicians to provide growers with technical recommendations in regards to on-farm improvements to their system as they may relate to MID operations. Growers benefit in the design and construction of their intakes, type of pump, screening, backflow, backflow prevention and filtration systems. MID also holds workshops partially sponsored by various local and statewide irrigation experts for the education and benefit of MID growers.

EWMP 4. Incentive Pricing Structure (§10608.48(c)(4))

Response: Implementing

Discussion: MID is implementing incentives and pricing related to the components identified in the CWC.

1. More Efficient water use at the farm level (§10608.48(c)(4)(A))

   The Board sets the rate for surface water deliveries and prices for the voluntary conjunctive supplemental water supply pool program annually, taking into account, among other things, the District's financial needs as well as its conjunctive management strategy at the time. All rates and prices are based on Cost of Service. On-farm efficiency is encouraged as a component of the District's conjunctive management strategy. MID sets surface water rates to reflect the actual cost of service taking into account all of the aspects of MID's water operations. Similarly, supplemental water supplies provided by conjunctive groundwater pumping are charged a price that reflects the actual cost of service for said supplemental supplies. This cost of service is higher than that for surface water due to a variety of factors, including the energy costs associate with conjunctive groundwater pumping. By charging volumetrically at rates that reflect actual cost of service, growers inherently pay more once they have used their surface water supplies due to the higher price of the conjunctive groundwater supplies.

   MID is currently developing a long range business plan that may result in alternative billing structures. This plan, known as MID's Water Resources Management Plan will determine costs necessary to meet the District's long-range operations and maintenance needs as well as costs required to further modernize its water conveyance and distribution facilities. Based on these costs, the District will consider a range of financial options that meet these needs while facilitating its various policy goals, such as robust conjunctive management.

2. Conjunctive Use of Groundwater (§10608.48(c)(4)(B))

   Please see the discussion above in Paragraph A, More Efficient water use at the farm level.

3. Increase Groundwater Recharge (§10608.48(c)(4)(C))

   Response: Implementing

   Discussion: Please refer to Section 5.1.5 Groundwater Recharge for a detailed discussion of MID's groundwater recharge activities, including its passive, in-lieu and direct recharge activities.

4. Reduction in problem drainage (§10608.48(c)(4)(D))

   Response: Implementing

   Discussion: MID follows guidelines and best management practices associated the Irrigated Lands Regulatory Program. There are no tile drains in District. In addition, MID does not allow drainage to its manmade system, and direct drainage to natural streams is intercepted by various District instream facilities for reregulation and reuse. MID also provides consultation to growers in regards to their tailwater recapture systems.

5. Improved Management of Environmental Resources (§10608.48(c)(4)(E))

Response: Implementing

Discussion: MID is engaged in the improvement of environmental resources throughout both its watershed and its service area. MID operates the Project in accordance with its FERC license and it numerous environmental management requirements. Further MID works with local and State environmental and resource agencies on a regular basis, including at the CDFW Merced River Fish Hatchery, to ensure the Merced River is managed as effectively as possible.

Example projects that MID is engaged in include:

A. River restoration design projects

B. Wetlands maintenance as part of an integrated recharge and flood control basin

C. Improved water management operations for co-equal goals such as modified river operations due to the drought

Regarding MID's service area, the District's rule book requires that grower's irrigation practices cannot harm other lands.

6. Effective management of all water resources through the year by adjusting seasonal pricing structures based on current conditions. (§10608.48(c)(4)(F))

   Response: Implementing

   Discussion: Please refer to Section 3.7 for a detailed discussion of MID's pricing practices.

EWMP 5. Lining or Pipelining Distribution System and Construct Regulatory Reservoirs (§10608.48(c)(5))

Response: Implementing

Discussion: MID has a robust capital improvement plan combined with rules for encroachment by land development that maintains a steady increase in the footage of lined canals and pipelines. In addition, MID is completing its Water Resources Management Plan, of which continued modernization of its facilities is a key component of the plan. This modernization plan includes additional regulating reservoirs, pipelines and lined canals, among other things.

Currently, out of about 850 miles of conveyance and distribution facilities, MID has 9 regulating basins (reservoirs), 107 miles of lined canals and 181 miles of pipelines. As MID implements its modernization plans, these numbers are expected to increase.

EWMP 6. Increased Flexibility to Water User (§10608.48(c)(6))

Response: Implemented

Discussion: MID prides itself on offering increasing flexibility to water users, as this is a key water conservation tool.

MID provides flexible deliveries, where feasible, as follows:

- Full on-demand delivery in specific district system areas where approved farmers can draw water on demand without notification to the District;
- Arranged on-demand delivery where farmers place routine calls to notify the control center that they are taking delivery;
- Constant flow delivery to large farms that distribute the delivered water among farm fields which applies mostly to rice farming and large fields, and
- Normal service where farmers place orders for water. Under this option, delivery is guaranteed within four days and normally received within 24 hours. Between 75 and 80 percent of accounts fall under this option.

The above flexibilities have been curtailed during the drought as needed to optimize usage of the facilities and to reduce seepage and captured spills.

In addition to the different form of deliveries, MID offers growers flexibility in ordering water:

- MID growers may request different flow rates, duration of irrigation, and start of irrigation at every water order request. MID staff has to meet the request within 72 hours from the start of irrigation. MID staff prides itself on meeting most requests within 24 hours of the requested start of irrigation. Delivery timing may be impacted in droughts in an effort to increase overall system efficiency.

- Growers can interact with Customer Service's personnel during work hours. In addition, growers can make orders 24-hours per day, seven days a week during the irrigation season via telephone (Interactive Voice Recognition, IVR), fax, and internet through a special web application. MID has also provided a phone app for water ordering.

MID's aforementioned modernization plan is focused on, among other things, increasing delivery flexibility to growers.

EWMP 7. Construct/Operate Tailwater and Spill Recovery Systems (§10608.48(c)(7))

Response: Implementing

Discussion: Most MID lands and laterals spill to local streams, which also serve as MID water conveyance facilities. Hence, a significant percentage of irrigation return flows and lateral operational discharges are automatically captured and re-regulated for supply. The Livingston Canal, Fairfield Canal, El Capitan Canal, and the Dean Canal/Casebeer system are totally automated and are designed to intercept operational discharges from laterals that terminate at these facilities. Changes include automating, improving, and possibly extending interceptor canals to reduce operational discharges and tailwater.

MID eliminated historical major spills by automation and constructing facilities that move water to other facilities rather than natural streams to direct such flows to meet a downstream commitment. Examples include:

- The Hartley Lateral to El Capitan Canal pipeline and SCADA sites that eliminated spills to the Hartley Sough,
- Casebeer Lateral Extension eliminated dependence on the spill to Duck Slough and moved flows to Deadman Creek to meet the District's commitment to the Merced National Wildlife Refuge.

- Automation and improvement completed to eliminate dependence on the Livingston Canal Spill.
- Connecting the Garibaldi Lateral "A" to the McCoy Lateral to eliminate dependence on the Garibaldi Spill.

MID continues to reduce operational discharges through various projects.

7. EWMP 8. Optimize Conjunctive Use (§10608.48(c)(8))

Response: Implementing

Discussion: Since MID's formation in 1919, both surface water and groundwater sources have been conjunctively used to meet water supply demands within the District, in part due to the fact that MID's water storage, conveyance and distribution facilities are upgradient and District growers have always had to rely exclusively on its local surface and groundwater resources for water supplies. MID's normal operating objective is to maximize surface water use subject to availability in order to preserve groundwater for use in years when surface supplies are limited.

Currently, MID has approximately 215 conjunctive groundwater wells overlying the Merced Groundwater Basin and conjunctively manages its surface water supplies with available groundwater supplies. In dry years, the District relies on recharge from stored deep percolation and water distribution system seepage to supplement surface water deliveries. This recharge is essential in sustaining a supply and demand balance for in-District acreage serviced by MID distribution facilities and In-District acreage that rely totally or partially on groundwater extracted by private wells.

In addition to intentional passive recharge through water distribution seepage, MID's conjunctive management activities have included highly effective in-lieu and direct recharge efforts.

In-lieu recharge efforts include the following:

1. Low Head Boosters Serving High Ground Areas: The base-line pumping is mainly generated from wells serving Highlands that cannot receive gravity water from surrounding canals. MID installed a number of low head boosters where water is pumped to these highland islands in years of adequate surface water supply. Currently, the overall in-lieu recharge volume is around 1,700 AF annually.
2. Highlands Pilot Project: MID constructed a pilot project in 1996 that replaced groundwater use with surface water in years of adequate surface supply by providing pressurized filtered water at the farm.
3. Groundwater Conservation Incentive Program: This program assists growers who use groundwater wells to convert to MID surface water conditioned on a commitment from the grower to purchase surface water when surface water is available. The incentive amount expands and contracts based on the years of commitment which maxes at eight years. However, years of surface water shortages do not count as the grower is expected to return to groundwater pumping. The program started in 1997 and since then:
   a) Total acres joined: 5,472 acres
   b) Groundwater saved per year 16,146 AF
   c) Total GW saved since the inception of the program: 117,800 AF

4. Encouraged reducing private groundwater pumping by increasing the flexibility of the system. By allowing changing water orders and delivering flows as close to the time requested, growers tended to use less groundwater in years of available water supply.

These in-lieu recharge efforts have resulted in an annual average recharge of 32,000 AF over the period of record for the water balance. Even greater in-lieu recharge is typically obtained when surface water supplies are ample.

MID's direct recharge efforts include two direct recharge basins. MID applies water to the basins in years of available surface water supply. No recharge is applied during years of surface water shortages, except when intercepting runoff generated from local precipitation. MID did not deliver water to recharge basins between 2012 and 2015 due to the hydrology. The Cressey Recharge Basin yield can be as high as 21 AF per day or 4,500 AF during the irrigation season. The El Nido Recharge Basin could receive water year round. On average, the basin could receive 800 AF outside the proper irrigation season and 2,950 AF during the irrigation season for a total of 3,750 AF annually.

MID's in-lieu and direct recharge efforts have yielded over 40,000 AF annually over the period of record for the water balance.

In 2002, the District completed a Prop 204 funded study to explore constructing a well field in the 25,000 acre southeast quadrant of its service area. The study recommended against development of a well field due to a limited aquifer, as based on geographic location and geologic conditions.

The District has participated in development of a regional AB 3030 Groundwater Management Plan. Local groundwater management objectives include maintenance of average groundwater levels at elevations similar to those observed in 1999, reduction of groundwater pumping during years when surface water is abundant and allowing use of groundwater during dry years adequate to meet local demands. These objectives are becoming harder to meet with the rise in agricultural development outside the District and urban expansion both totally dependent on groundwater. Ongoing regulatory proceedings that threaten to take additional surface water for instream purposes also threatens MID's conjunctive use activities.

MID is actively pursuing grants under the IRWM funding for in-lieu recharge projects by intercepting excess flood flows in coordination with other entities in the basin.

EWMP 9. Automate Canal Control Devices (§10608.48(c)(9))

Response: Implemented.

Discussion: MID applies automation to all new improvements. For example, new projects are automated by table topping facilities (level top canals) constructing of pipeline or the installation of long crested weirs. In addition, MID has installed numerous automated gates at head of laterals and check structures.

MID has installed automation features as shown on Table 7.4.

Table 7.4
MID Structure Automation

Automation Feature	Applied Control	No. of Gates Installed	Recently Added Since Last Plan
ITRC Flap Gate	Level	20	0
Langmann Gate	Level	3	0
Lopac Gate	Level	16	0
Rubicon Flume Gate	Level/Flow	13	0
Rubicon Slip Gate	Level/Flow	2	0
Downward Opening Weir Gate	Level	9	3
Long Crested Weirs	Level	22	3

Expansion of SCADA Facilities

The initial SCADA system, constructed in 1996, was comprised of 15 remote sites, a repeater site, and a control room. By 2000 the SCADA system increased to a total of 25 remote sites. Over the next several years the SCADA system increased to a total of 37 remote sites by 2008. A SCADA site was added in 2011, which was a site expansion, to bring the total of remote sites to 38. In 2012 the Cressey Basin (recharge) site was installed which effectively added 5 remote locations along with 3 additional sites along Hwy 99 for a total of 46 remote sites. The SCADA system was expanded again in 2013 by adding 9 sites in the Livingston area for a total of 55 remote sites. The Lake Yosemite Tower site was added in 2014 for a total of 56 remote sites.

Infrastructure for two new sites took place in 2015, but only one of the two sites is SCADA ready for a current total of 57 remote sites comprising a mix of solar and AC powered sites (30 control sites and 27 monitor sites).

MID has SCADA facilities operating with 24-hr attendance. Since 2008, DSO and managers have real time access to SCADA through portable computers that can be operated from vehicles in the field.

EWMP 10. Facilitate or Promote Customer Pump Testing and Evaluation (§10608.48 (c)(10)).

Response: Implementing

Discussion: The MID has staff in the Engineering and Water Operations departments who manage the pump testing. Table 7.5 lists the number of pumps tested in the years between 2012 and 2015.

Table 7.5
Number of Pump Tests

	MID			Private		
Year	**Wells**	**Boosters**	**Total**	**Wells**	**Boosters**	**Total**
2012	12	16	28	0	36	36
2013	126	17	143	0	10	10
2014	41	7	48	0	18	18
2015	233	0	233	0	14	14

MID provides support to MID growers by promoting pump testing and undertaking workshops attended by local professionals.

EWMP 11. Designate a Water Conservation Coordinator (§10608.48 (c)(11)).

Response: Implementing

Discussion: Hicham Eltal P.E. was appointed as Water Conservation Coordinator on December 15, 1998. His current position is Deputy General Manager for Water Supply/Rights

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

A. On-farm irrigation and drainage system evaluations (§10608.48 (c)(12(A))

Response: Implementing

Discussion: The District has a full time technician dedicated to assist growers in installing the most compatible irrigation system with District facility. In addition, the technician steers growers to install systems that prevent discharges of applied water to District facilities and maintain positive air gaps between groundwater and surface water facilities. The District also holds workshops introducing growers to new technologies and vendors to best optimize their system.

B. Normal year and real-time irrigation scheduling and crop evapotranspiration information (10608.48 (c)(12)(B)

Response: Implementing

Discussion: MID supports CIMIS Station No. 148 and provides links to CIMIS data over the MID website. The District also supports a full-time Engineering Technician who is dedicated to support growers' irrigation needs.

As part of its water management services, the District provides water delivery flow rates and times of delivery that are flexible and responsive to customer orders. The District also provides customers with monthly bills reporting water usage. A web page allows a grower to trace the more recently posted consumption for all of its water accounts (fields).

MID staff attends workshop and coordinates with the UC Extension regarding growers' education.

EWMP 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. (§10608.48 (c)(13))

Response: Not Applicable

Discussion: MID relies exclusively on its local surface and groundwater resources for water supply.

EWMP 14. Evaluate and Improve the Efficiencies of the Supplier's Pumps. (§10608.48 (c)(14)).

Response: Not Applicable

Discussion: As mentioned, MID relies solely on its own water resources and does not have a supplier.

~End of Section~

THE EL CAPITAN CANAL

APPENDIX A

IRRIGATION DISTRICT RULES AND REGULATIONS GOVERNING THE DISTRIBUTION OF WATER

The MID Rules and Regulations Governing the Distribution of Water is available on the MID website at http://www.mercedid.org/default/assets/File/WaterRules.pdf or available on hard copy at the MID Main office, 744 W. 20th Street, Merced.

APPENDIX B

WATER RATES

Volumetric Billing Structure			
Year[1]	Surface Water Rate ($/Acre-Foot)[1]	Conjunctive Supplemental Water Supply Pool Program[3] ($/Acre-Foot)	Municipal and Industrial (M&I) ($/Acre-Foot)
2010	$18.25	NA	$125.00
2011	$18.25	NA	$125.00
2012[2]	$18.25	NA	$125.00
2013	$23.25	$73.25	$125.00
2014	$75.00	$110.00	$125.00
2015	$100.00[4]	$225	$225.00

1. MID converted from a calendar year budget to a fiscal year budget (April 1 to March 28) in 2013. Therefore, years 2010 to 2012 are calendar years. Years after 2012 are fiscal years.

2. MID implemented a tiered water rate for this year. The base surface water rate was $18.25/acre-foot up to 2.5 acre-feet/acre, and $23.25/acre-foot for deliveries above 2.5 acre-feet/acre.

3. The voluntary conjunctive supplemental water supply program was implemented in 2013. Rates shown prior to this reflect total water deliveries, including conjunctive supplemented water supplies.

4. Due to the ongoing drought, MID did not allocate surface water supplies during 2015. There was a small, emergency surface water diversion in July. Surface water supplies during this short irrigation run were charged out at $100.00/AF.

APPENDIX C

Merced Irrigation District Drought Management Plan

Background and Overview

Governor Brown issued Executive Order B-29-15 on April 1, 2015, directing agricultural water suppliers to include a detailed drought management plan (DMP) that describes the actions and measures the supplier will take to manage water demand during drought.

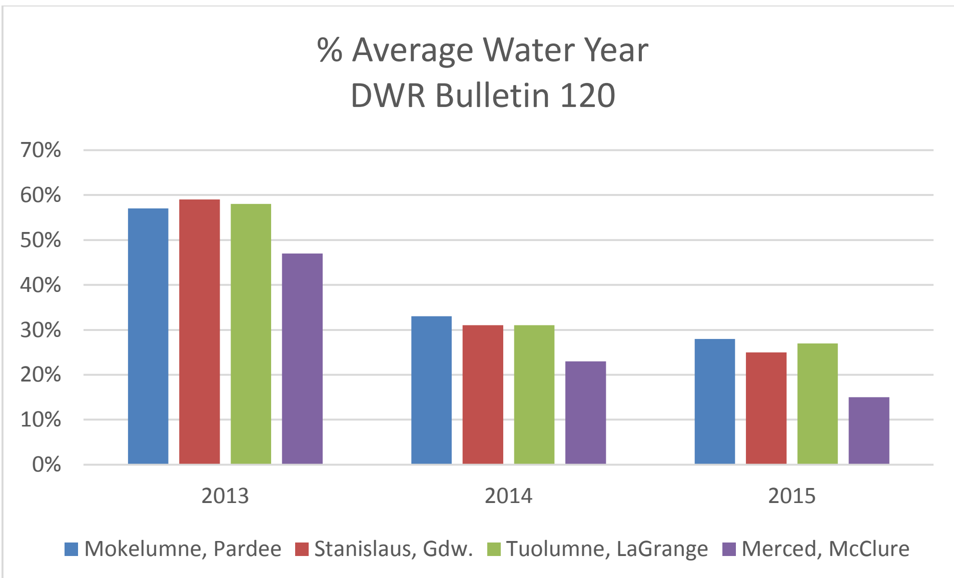
According to DWR's Guide Book, a minimum, the DMP should include the following components:

1- *Monitoring of hydrologic conditions to assess available Supply and drought severity*
2- *The district's policy and process for declaring a water shortage and implementing the water shortage allocation and drought management plan.*
3- *Operational Adjustments- changes in district water management and district operations to respond to drought, including canal and reservoir operations and groundwater management.*
4- *Demand Management- policies and incentives in addition to the water shortage allocation plan to lower on farm water use.*
5- *Alternative Water Supplies- discuss the potential if possible for the district to obtain or utilize additional water supplies. These supplies could include transfers from another water agency or district, the use of recycled water and desalination of brackish groundwater or drainage water.*
6- *Stages of Actions- include the stages of action and corresponding levels of drought severity that district will implement in response to the drought.*
7- *Coordination and Collaboration- include a description on how coordination and collaboration with other local districts and water agencies or regional groups will be used in drought response.*
8- *Revenues and Expenditures- describe how the drought and lower water allocations will affect the districts revenues and expenditures.*

1- Monitoring of hydrologic conditions to assess available supply and drought severity

The Merced River watershed is considered a protected watershed in terms of criteria for the simulation of extreme storm events such as for the Probable Maximum Flood. With a significant portion of the watershed represented by the Yosemite Valley nestled amongst peaks in excess of 13,000 feet between the upper San Joaquin River and the Tuolumne River watersheds, runoff from the Merced River watershed tends to be more sensitive to drought conditions. In the current drought the Merced River received proportionately less than other major tributaries to the San Joaquin River, see Figure 1-1. This additional impact was similarly reflected in the 1976-1977, 1987-1992. The sensitivity to droughts is compounded by the size of the New Exchequer Reservoir. New Exchequer Reservoir's maximum storage (approximately 1M AF) is almost the same as the average yield of the watershed, and the maximum carry over storage for New Exchequer Reservoir is 67% of the average yield. Further, New Exchequer Reservoir in the most upstream impoundment on the natural Merced River system, with no other supplemental upstream reservoirs such as the case on all adjacent watersheds (e.g. Big Creek project to the south and Hetch Hetchy Reservoir Tri-Dam to the north). For these reasons Merced Irrigation District (MID or the District) has been traditionally more careful in reacting to dry conditions. The District owns and operates New Exchequer Reservoir, so it is incumbent on the District to make appropriate decisions for withdrawal from storage to best optimize the District's limited water supply. Simultaneously, the District keeps in consideration the status of the groundwater basin conditions, and its groundwater well field condition.

Figure 1-1



Each year and circumstances are unique but generally, three components trigger a drought response at MID: (a) New Exchequer Forecasted Runoff, (b) Carryover storage in Lake McClure, and (c) the anticipated water balance to carry an irrigation season (local moisture presence within MID services area and the status of local streams).

(a) New Exchequer Forecasted Runoff:

MID relies on services provided by DWR and the California Nevada River Forecast Center (CNRFC) to estimate forecasted runoff into New Exchequer Reservoir. MID is a member and a contributor to the DWR California Cooperative Snow Surveys. However, early DWR estimates such as its February 1st Bulletin 120 can be drastically different from April 1st estimates. Therefore, MID tends to delay its determination of available surface water supplies into March, and sometimes April. The first not dry year after a series of drought years is more challenging as antecedent conditions and carryover storage provide the potential for an adequate water supply even if effective precipitation was as late as April, such as with 2004.

MID staff keeps the public informed through presentations at its Board of Directors meetings and its MID Advisory Committee meetings.

(b) Carryover Storage in Lake McClure:

In addition to forecasted runoff, MID accounts for available carry over storage in Lake McClure when determining its available surface water supplies in any given year, and when making decisions in response to drought conditions. Full carryover storage can delay the impacts of a drought; however MID takes precautionary actions to remain prepared for dry years, such as in 2012 when an additional 19,000 AF, in addition to its base conjunctive groundwater management activities, were introduced to increase system efficiency and maintain certain carryover storage for 2013.

(c) Anticipated Water Balance:

MID gages available moisture on the ground using existing ET stations, observed soil conditions, and growers' feedback. A year of lower than desired snow pack and runoff may be offset with continual moisture within the service area during the spring months, which could reduce demand by as much as 25% in certain years, as was the case in 2004.

However, beyond the first year of a drought, prediction of a second year of a drought becomes easier, since it takes significant precipitation events impacting runoff to New Exchequer Reservoir before conditions can be reversed.

2- The District's policy and process for declaring a water shortage and implementing the water shortage allocation and drought management plan.

The District's Board of Directors determines annual surface water supply availability, expressed as available water per acre for Class I and Class II users. The Board also determines estimated required groundwater pumping above the base pumping. Staff develops and reviews runoff projections and projected carryover storage and considers past operations experience in developing recommendations to the Board. For the drought years of 2012 to 2015, available surface water supplies ranged from an adequate surface water supply immediately following the wet year in 2011, to essentially no available surface water following 3 years of intense drought.

3- Operational Adjustments - changes in District water management and District operations to respond to drought, including canal and reservoir operations and groundwater management.

MID takes the following actions:

Preserving Storage: MID adjusts its in-river flow releases and through system flow commitments to other entities in dry years, as permitted by the various agreements and licenses. MID works with water users along the Merced River to reduce waste. For example, MID assigned two Distribution System Operators to coordinate with riparian users on the Merced River for 2013, 2014 and 2015. The District may also reduce the period of the river diversions as part of a shortened agricultural irrigation season. MID shortened the irrigation season for 2014 and 2015 substantially. However, there are a number of factors that may influence the length of MID's river diversion period in any given year based on hydrology and storage.

MID owns and operates approximately 215 groundwater wells as part of its conjunctive water management operation. The District manages its groundwater wells to supplement available surface water supplies and increase system efficiency. The amount of conjunctively managed groundwater used each year depends on many factors. However, the District's wells pumping capacity has declined somewhat due to drops in groundwater levels in recent years. For example, in 1977, MID was able to conjunctively pump approximately 190,000 AF. Today, staff estimates that the District may be able to conjunctively pump approximately 80,000 acre feet of groundwater during a dry year. As for efficiency, MID runs some wells to reduce operational discharges outside the District. In order to reduce spills, MID may reduce normal flexibility to its growers to ensure that water in its open gravity system is efficiently turned over between growers.

Table 3-1 demonstrates MID water allocations during the 2012-2015 drought.

Year	Class I AF/AC	Class II AF/AC	Groundwater Supplemental Pumping (AF)
2011	No Restrictions	No Restrictions	4,113
2012	No Restrictions	No restrictions	17,075
2013	2.4	1.2	56,715
2014	1.1	0.55	45,717
2015[1]	0	0	36,857

[1]No surface water was allocated in 2015. There was a short irrigation run in early July consisting of a 13,250 acre-foot diversion.

In extreme conditions, such as 2015, MID altered its distribution system by installing numerous cofferdams to segment the system and manage multiple, discreet delivery service areas. Additionally, MID allowed growers to install temporary connections and cross facilities that helped convey both private and MID conjunctive groundwater supplies. MID has a robust water exchange and water wheeling policy where MID growers can use its distribution system to optimize available water supply. In addition, MID has been developing a long-term Water Resources Management Plan which includes system and policy decisions that further bolster MID operation during a drought.

4- Demand Management - policies and incentives in addition to the water allocation plans to reduce on farm water demand.

MID encourages on-farm water conservation and demand reduction though a number of actions. These actions may be "ramped up" during a drought, and may vary depending on the severity of the drought:

- Education and outreach to growers:
  - During the most recent drought, MID made an emergency declaration notifying the public of the severity of the impacts experienced by the ongoing drought and changes that customers would experience from its normal operations and to relate the severity of the conditions to MID growers. That drought declaration remains in place to date.
  - MID holds numerous large scale town hall meetings to educate growers of the available forecast reflecting hydrology and storage conditions. Growers are informed of allocations, costs etc. See Table 4-1 for town hall meetings held since 2013. See all also a sample of invitations to such meetings in Figure 4-1.
  - MID also reaches out to its MID Advisory Committee to discuss various policies and/or practices aimed at dealing with drought conditions.
  - MID invites experts in agricultural irrigation to educate growers on best management practices to conserve water. For example, MID invited UC Cooperative Extension experts to provide a discussion on deficit irrigation practices.
  - MID discusses policies relating to water management and drought in its monthly journal "The Current."
  - MID also communicates through its website with its growers. A Drought Watch portal may be viewed at: http://www.mercedid.com/index.cfm/water/drought-watch/

Table 4-1

<u>2014 Town Hall Meetings</u>	<u>2015 Town Hall Meetings</u>
• February 7, 2014	• February 25, 2015 • March 25, 2015 <u>Operations Town Hall Meetings</u> • March 16 – 20, 2015

Figure 4-1 Town Hall Meeting Invitations

- Irrigation Season Length:

  MID may shorten the length of its surface water diversion from the Merced River, but that opportunity may be restricted at times. Nevertheless, as a water management and drought management tool, MID has sometimes delayed the start of its irrigation season and had an earlier end of season. For example, in 2014, river diversions were 183 days, the shortest in the last 22 years (1993-2014). MID through various variances and petitions to divert more water from Lake McClure was able to extend its irrigation season past September 30, 2014 for the benefit of fisheries in the Merced River. Still this was the shortest season on record at the time since the construction of New Exchequer Dam. In 2015, unfortunately there were no surface water supplies available for District growers, except for an extremely small opportunity lasting just 15 days during the month of June. The California Department of Fish and Wildlife (CDFW) encourages a longer surface water irrigation season to maintain lower water temperatures in the Merced River for the benefit of resident salmon populations.

- Water Pricing:

  In 2014 MID increased surface water prices to $75/AF. The water price prior to 2013 was $18.25/AF. At the same time in 2014, the MID Board set its conjunctively managed groundwater price at $110/AF.

- Change in MID Rules and Regulations:

  To ensure maximum efficiency and help minimize what are typically severe impacts from drought conditions, MID may deviate from the flexibility it normally offers to growers. In most years, MID allows its growers substantial input on decision points such as irrigation flow rate, duration, start and finish of an irrigation. However in droughts, the Districts flow rates and volumes are usually reduced, consequently MID strives to reduce these operational discharges. One of the means to reduce operational discharges is to dictate the date, start, and finish of a given irrigation.

Personnel were also empowered to terminate irrigations if waste or unnecessary losses were observed.

- Water Theft Penalties:
  MID Board increased penalties for water thefts:
  - First Time Unauthorized Use: The additional charge for the water taken will be three times the District's in-season water in effect at the time of the unauthorized use for each acre-foot taken, plus one-thousand dollars ($1,000.00).
  - Subsequent Occurrences of Unauthorized Use: The additional charge for the water taken will be three times the District's in-season water in effect at the time of the unauthorized use for each acre-foot taken, plus one-thousand dollars ($1,000.00), and shall result in forfeiture of irrigation water for the remainder of the season.
  - All unauthorized use of water shall be deducted from the grower's allocation.

5- Alternative Water Supplies - discuss the potential if possible for the District to obtain or utilize additional water supplies.

Water Transfers: MID is geographically situated in a location that is up gradient from other surface water providers and therefore it cannot receive foreign/supplemental surface water supplies such as from the CVP or State Water Project. However, MID was able to purchase a limited amount of water in 2008 from the Stevinson Water District (SWD). MID accounted for the flows by reducing deliveries to SWD.

Recycled Water: Except for the City of Merced, all recycled water within the Merced area is fully applied to agricultural lands. As for the City of Merced, recycled water is applied to agricultural land owned by the City as part of its land application mitigation expanding the City's waste water treatment plant. Excess water is released into water ways where some is naturally intercepted by MID system.

Desalination of Brackish Water: This method is currently not feasible as the shallowest saline water is west and down gradient of the District.

Drainage Water: Some drainage water is intercepted by MID system and used for irrigation.

6- Stages of Actions - include the stages of action and corresponding levels of drought severity that District will implement in response to the drought.

MID does not have certain triggers to announce a drought. As the above indicates, MID Board of Directors makes such decisions on an annual basis, based on existing conditions and information received from staff. MID Board of Directors takes such decisions balancing multiple issues at the time, as no two droughts are the same.

7- Coordination and Collaboration -

MID exchanges its experience with other irrigation agencies, both locally and statewide throughout a drought. The District shares its actions with other purveyors through its meetings at the Merced Area Groundwater Pool Interests, especially Merced County which has recently passed a groundwater sustainability ordinance that became effective on April 1, 2015.

Further, the District participates in and cooperates with the Merced County Drought Task Force and the State Office of Emergency Services to respond to local drought emergencies.

The District also collaborates with other reservoir operators, DWR and the Army Corps of Engineers as part of the flood coordination which work included climate and weather tracking.

The District also cooperates with UC Merced under the Sierra Nevada Institute (SNI) to explore increasing runoff and improve forecasting. The District has cooperated with SNI to pursue two approved Integrated Water Management Plan projects that are currently active.

In 2014, MID submitted a Temporary Urgency Change Petition from the SWRCB after coordinating with the California Department of Fish and Wildlife. Through changes in management of water diversions and allowing for diversions below the regulatory minimum pool at New Exchequer Reservoir, MID provided a longer river diversion period and made a spring pulse flow release to the Merced River. The temporary emergency changes in management benefitted water temperature, provided the District with slightly higher water supply, and provided a spring pulse flow in the Merced River for out-migrating salmon. Nevertheless, MID opted to not utilize the full reduction in storage allowed by the petition to preserve storage as best possible

In 2015, the District also secured a petition for Lake Don Pedro Community Services District to be able to divert flows below the minimum pool elevation at Lake McClure.

8- Revenues and Expenditures - describe how the drought and lower water allocations will affect the Districts revenues and expenditures.

The District relies heavily on its water sales to maintain its general fund and reserve. As the water levels and flow rates have been extremely low in the last two years, hydro generation was almost non-existent.

In the extended drought of the 1980s, as well as the current drought, MID relied on increased water rates, utilizing available reserves, and postponing certain capital projects to preserve water resources reserves to the fullest extent possible. During this drought, MID was fortunate to have attained grants for capital projects it can utilize its own crews to complete.

Further, MID controls staff overtime, reduces nonessential travels and training. For 2015, MID expenditure for aquatic growth was reduced due to dry canals.

Additional Actions:

In addition to the actions summarized above, MID is exploring various new policies and changes to existing policies to benefit surface water supply availability and reliability during droughts as part of the Districts Water Resources Management Plan. MID is working on an assembly of software aimed at optimizing the District resources that would be available for MID Board of Directors. Furthermore, MID is active with UC Merced on exploring watershed management in the Merced River Watershed. The District is also pursuing physical modification to New Exchequer Dam Spillway to increase carryover storage.

References

DWR. 2015. A Guidebook to Assist Agricultural Water Suppliers to Prepare a 2015 Agricultural Water Management Plan. California Department of Water Resources.

MID Board Meetings

Water reports and board meeting correspondence is available on the MID website at:

http://www.mercedid.com/index.cfm/about/novusagenda-boards-agendas-minutes/

MID General Drought Resources (Attachment 1)

Drought resources provided to MID growers focus on a robust public drought outreach campaign, supplemented by the MID website, letters to growers, social media and press releases.

MID public outreach included hosting District-wide grower meetings prior to each of the last several irrigation seasons. These outreach meetings included the following topics:

1. Detailed review of existing hydrology conditions, storage levels and hydrology forecasts – this information allows growers to plan for scenarios that most have never been faced with.

2. Technical presentations from experts from the UC Cooperative Extension in Merced regarding irrigation practices during droughts.

3. Detailed presentations, questions, and answers regarding water delivery implementation in drought years, such as ordering and scheduling guidelines, relaxed rules on water reallocation and wheeling amongst growers, stricter policies regarding water theft, etc.

4. On Farm Resources: Crop Irrigation Tables for a Dry Year.

In addition to District-wide meetings, MID operations personnel met with growers in small groups throughout the District to review their plans, answer questions regarding available water supply, operations, and implementation rules.

Beyond these special outreach meetings, MID staff provides presentations regarding water supply issues at MID Board meetings.

To supplement these outreach events, MID sends information via mail to each grower. These letters typically summarize information presented at the outreach meetings, update growers in any changes to the forecasted available water supply, and may provide additional technical information, such as evapotranspiration estimates for various local crops.

MID also maintains a robust website that allows growers to view their orders, deliveries, water allocations and remaining water available to each grower, among many other things. By providing this information to growers in an easily accessible fashion, growers are better able to plan for, manage and survive the current drought. In addition to water delivery information, the MID website provides a comprehensive “Drought Watch” web portal that keeps growers up to date with the latest MID drought communications as well a resource center with direct links to MID water storage updates, Merced County drought assistance, local weather forecasts, daily snow reports, State of California drought assistance, UC California drought watch and much more.

Attachment 1

MERCED IRRIGATION DISTRICT

January 27, 2014

Dear Grower,

Californians are in the midst of a critical drought. Growers in the Merced Irrigation District are no exception. Three consecutive dry years have left Lake McClure, MID's storage reservoir, at historic lows. Even worse, no significant show of rain is on the horizon. Absent of significantly above average rainfall in the next three months, MID growers will likely receive mere acre inches of irrigation water this year, rather than acre feet. The irrigation season is also likely to be extremely short. Although this will be a difficult year, MID is committed to doing everything possible to help our growers during these dire times.

MID has sent a petition to state agencies requesting operational flexibility for some of our requirements on the Merced River and at Lake McClure. MID officials and board members will be talking with growers in the coming weeks and receiving input before the irrigation season begins. Several upcoming meetings are being planned to provide as much information to growers as possible. The first meeting will be held February 7th at the Merced County Fairgrounds (see enclosed flyer for more information). The District will continue to do everything possible to keep growers informed as the irrigation season approaches.

To help keep you informed of the latest updates, we have created a "Drought Watch" web page on our website at www.mercedid.org. There you will find a host of useful resources and information, including current conditions at Lake McClure, weather forecasts, and drought planning tips and techniques.

As always, please don't hesitate to call us at 722-5761 or stop by the office at 744 W. 20th Street, Merced.

There is no question this will be one of the toughest years we have experienced, but you can count on us to do everything possible to help you through it.

Sincerely,

Bryan Kelly
Deputy General Manager, Water Resources

(209) 722-5761 744 West 20th Street P.O. Box 2288 Merced, California 95344-0288
Administration / FAX (209) 722-6421 • Finance / FAX (209) 722-1457 • Water Resources / FAX (209) 726-4176
Energy Resources / FAX (209) 726-7010 • Customer Service (209) 722-3041 / FAX (209) 722-1457

MERCED IRRIGATION DISTRICT

WATER & POWER

March 4, 2015

Dear MID Grower,

At the February 24th MID Board of Directors meeting, information regarding limited available water supplies resulting from the fourth year of a 4-year drought was presented. Based on this information, the Board authorized MID staff to implement certain components of the 2015 Water Management Implementation Plan (WMIP). The 2015 WMIP is enclosed for your review. As always, please don't hesitate to call Customer Service at 209-722-2720 or stop by the office at 744 W. 20th Street, Merced if you have any questions. The 2015 WMIP includes the following key components:

1. Currently, No Available Surface Water Supply for 2015 (no initial surface water allocation): Currently, the District's surface water supply reservoir, Lake McClure, remains at approximately 8 percent of capacity. Under federal and state regulations, no stored water can be diverted for irrigation once the reservoir has fallen below 11.5 percent, or 115,000 acre feet. This is subject to change based on future hydrology.
2. Limited Availability to Supplemental Water Supply Pool Program (Program) in 2015:
    a. Available by conjunctive groundwater pumping.
    b. Availability based on location of parcel and availability of MID well service.
    c. Contact MID Customer Service to determine whether your property has access to the Program.
    d. Program water will be charged at a price likely in excess of $205.00/AF (to be determined at the March 17th Board of Directors meeting in association with the fiscal year budget adoption process). The price of this voluntary Program is required to meet certain long-term debt covenants associated with financing the Federal Energy Regulatory Commission relicensing effort for the Merced River Hydroelectric Project, during a period with no projected surface water deliveries and associated revenue.
    e. If you are interested in subscribing to the Program, please complete the "2015 Supplemental Water Supply Pool Program Application" and return it with your pre-payment to the District by March 20, 2015. The Application is included with the enclosed 2015 WMIP.
3. Private Groundwater Wheeling: Private Groundwater Wheeling is generally described as the conveyance of private well groundwater discharged from an upstream contributing parcel through an identified portion of the MID conveyance system to a downstream receiving parcel. If you are interested in private groundwater wheeling, please complete the enclosed Groundwater Wheeling Application to be considered for wheeling. Daily Wheeling fees will be waived.

(209) 722-5761 744 West 20th Street P.O. Box 2288 Merced, California 95344-0288
Administration / FAX (209) 722-6421 • Finance / FAX (209) 722-1457 • Water Resources / FAX (209) 726-4176
Energy Resources / FAX (209) 726-7010 • Customer Service (209) 722-3041 / FAX (209) 722-1457

This is going to be a difficult year. Although we are all hoping for the best – which would be some late-season snow storms - MID and our growers need to continue to prepare for the worst. MID is committed to doing all it can to assist our growers and to be ready for the limited season ahead.

For the latest information, growers may visit the Drought Watch page at www.mercedid.org.

Sincerely,

Bryan Kelly
Deputy General Manager, Water Resources

MERCED IRRIGATION DISTRICT
WATER & POWER

2015 Water Management Implementation Plan

March 4, 2015

The Merced Irrigation District's annual Water Management Implementation Plan (Plan) provides a framework for monitoring and accounting for water deliveries, which provides MID growers flexibility regarding the use of both MID and non-MID water supplies while helping to ensure that the following water management objectives are achieved:

- Maintain Equitable Service to All Eligible Parcels under adopted Implementation Criteria; and,
- Control and Properly Account for All Water Conveyed through MID Facilities

To achieve these objectives, guidelines have been developed that will govern the following practices:

- General Guidelines
- Account Setup
- 2015 Supplemental Water Supply Pool Program
- Private Groundwater Wheeling Management

General Guidelines

1. MID's Manager of Water Operations or his designee shall make all necessary determinations regarding compliance with these guidelines.
2. Requests to implement any described transaction will be considered on a case-by-case basis consistent with MID's water management objectives for the season.
3. Water orders and deliveries shall be initiated per the established MID Water Distribution Rules Governing Distribution of Water, except where provisions in this policy may differ.
4. Tail water may not be discharged into the MID water conveyance system.

Account Setup:

1. Water Accounts consist of portions of one or more parcels that are farmed as a unit.
2. Customer Accounts (Customer ID's or Billable Accounts) consist of one or more Water Accounts owned or leased by the same entity.

Limited 2015 Supplemental Water Supply Pool Program

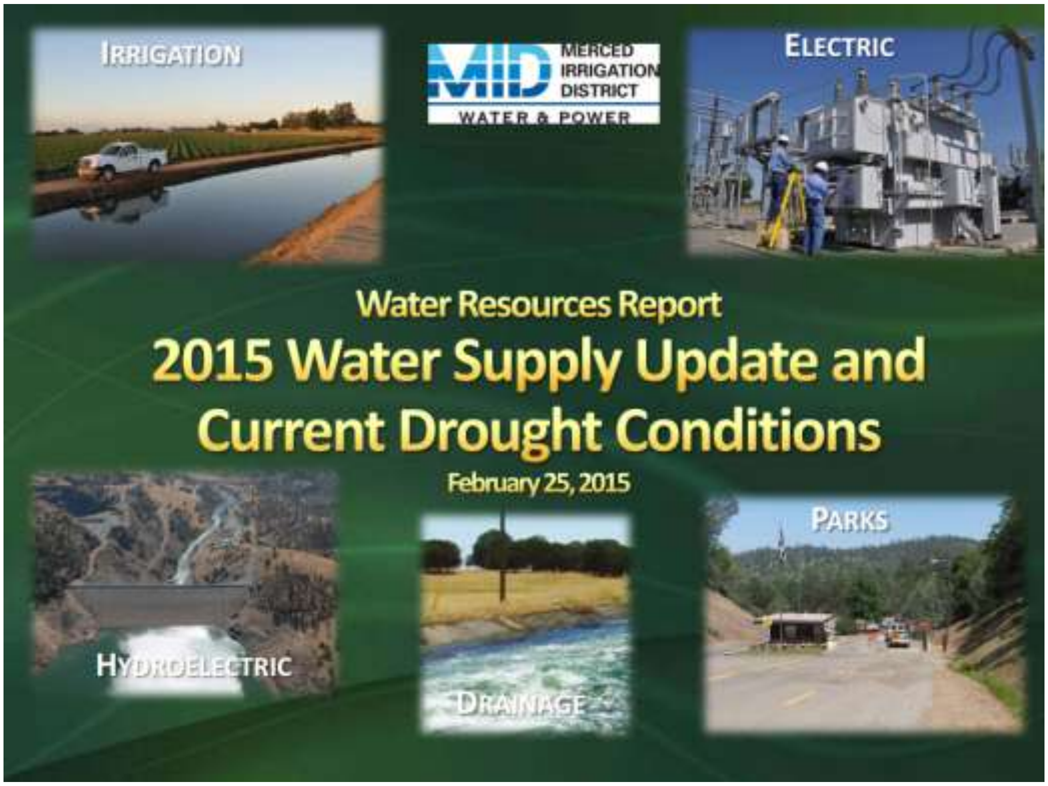
1. The Board has authorized a limited Supplemental Water Supply Pool Program (Program) for Class I water users through conjunctive groundwater pumping, effective April 1, 2015.
    a. This is a voluntary program.
    b. Availability based on location of parcel and availability of mid well service.

2. Process for Growers to Subscribe to Program Water
    a. If you are interested in subscribing to the Program, please complete the "2015 Supplemental Water Supply Pool Program Request Form." The request form is attached.
    b. Prepayment is required for participation in the Program. The amount of the prepayment is $50/Acre.
    c. The prepayment will be applied as a credit to your account. For example, if your water account acreage is 100 acres and you apply for Water Account AT123, consisting of 100 acres, then the prepayment required at the time you submit your request form would be 100 x $50 = $5,000.

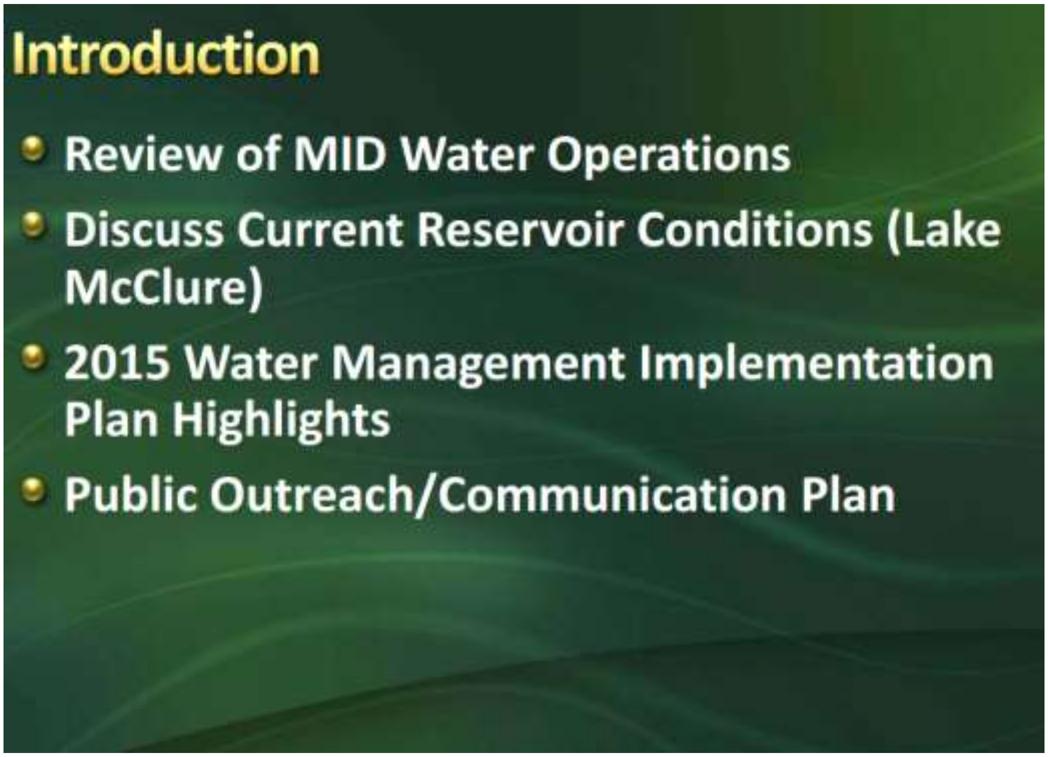
<u>Private Groundwater Wheeling</u>

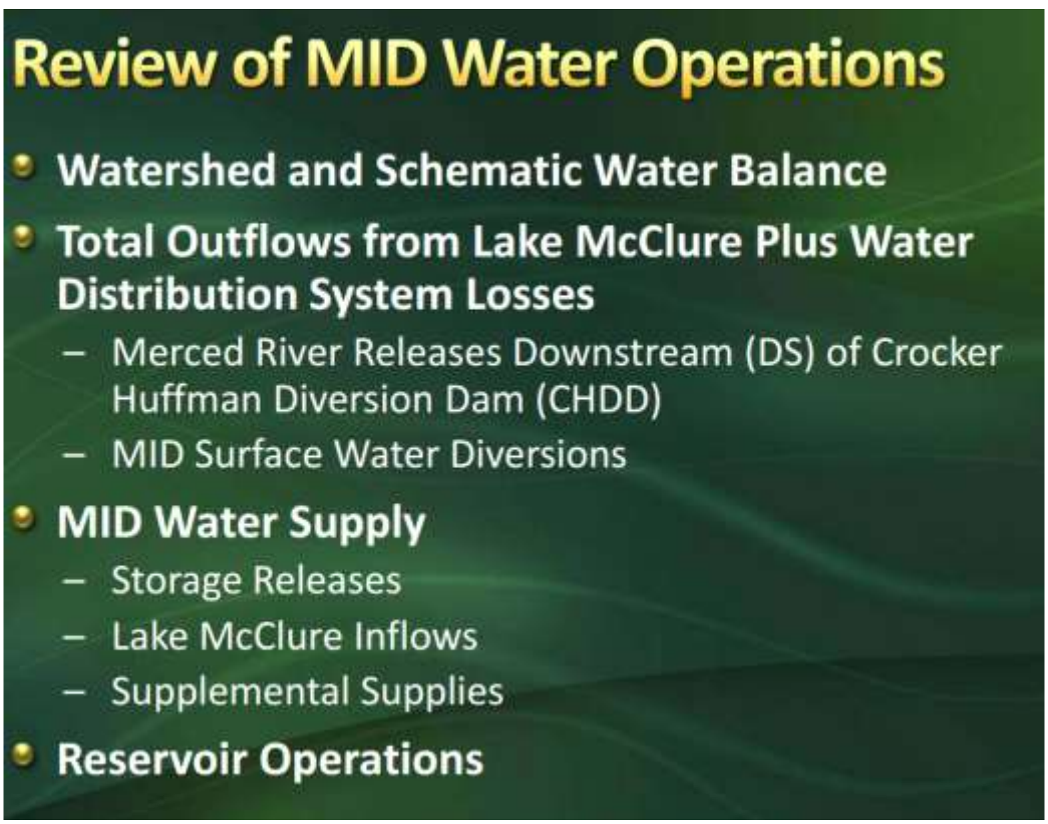
1. Private Groundwater Wheeling can be generally described as the conveyance of private well groundwater discharged from an upstream contributing parcel through an identified portion of the MID conveyance system to a downstream receiving parcel.
2. No Daily Wheeling Fee.
3. Temporary Modifications to MID Facilities for Wheeling Purposes.
    a. Allowed with Approval of MID Engineering Department.
    b. Temporary Pump Permit Required (fee waived).
    c. All Infrastructure Costs Borne by Applicant.
4. General Guidelines:
    a. Growers must complete the Groundwater Wheeling Request Form to be considered for wheeling. Approval of the request is subject to the guidelines discussed below.
    b. It is imperative MID maintain control over use of its water distribution system and facilities. Conditions on wheeling of private groundwater will be required at MID's discretion when it is deemed necessary to meet its water management objectives for the season.
    c. All private wells discharging into MID conveyance facilities must be equipped with a properly installed and calibrated flow meter prior to the date of groundwater wheeling.
        i. Exceptions to this requirement require approval of the Manager of Water Operations (i.e., acceptable method of accounting for water is determined).
        ii. The meter must be installed in accordance with the manufacturer's recommendations (instantaneous flow rate and totalizer required).
        iii. Calibration statements are required and must have been obtained by the use of an outside contractor acceptable to MID. Statements must be current (within the last 24 months preceding the wheeling activity).
        iv. If necessary, MID will perform a flow test to properly calibrate a meter.
5. Losses to be Determined by MID.

6. The applicant must make prior arrangements with the appropriate Distribution System Operator (DSO) before any water is wheeled in MID's distribution system.
7. Any temporary modifications to the MID canal system or facilities for wheeling purposes will be paid for by the applicant and will be subject to control and approval by MID.
8. Private well discharges to MID facilities may only be started or stopped with authorization from MID Irrigation Operations. An authorization shall be approved in writing, or any other form acceptable to the MID.
9. All private well pump/motor assemblies shall be safely accessible to MID employees.
10. MID shall have the right to test the water quality for any private well. MID retains the right to terminate groundwater wheeling operations if the private well discharge quality is deemed by MID, to be detrimental to MID operations, canal water quality or operational discharges. Any testing costs shall be solely borne by the applicant.

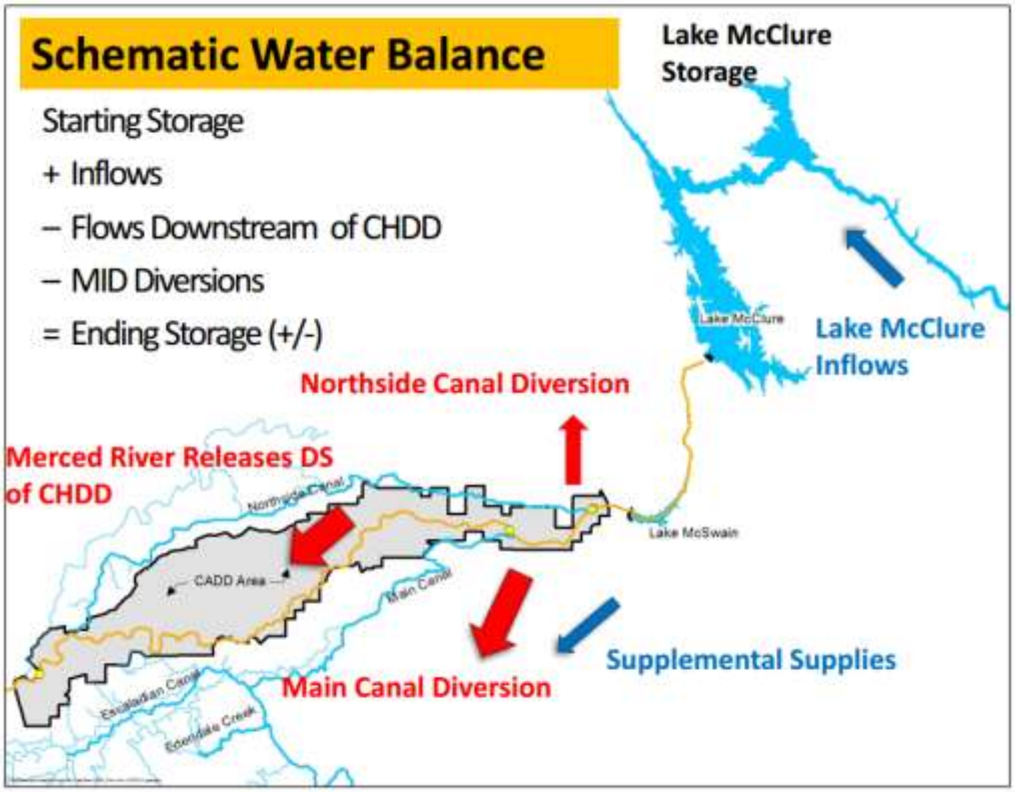

IRRIGATION
MERCED IRRIGATION DISTRICT
WATER & POWER
ELECTRIC
Water Resources Report
2015 Water Supply Update and Current Drought Conditions
February 25, 2015
PARKS
HYDROELECTRIC
DRAINAGE

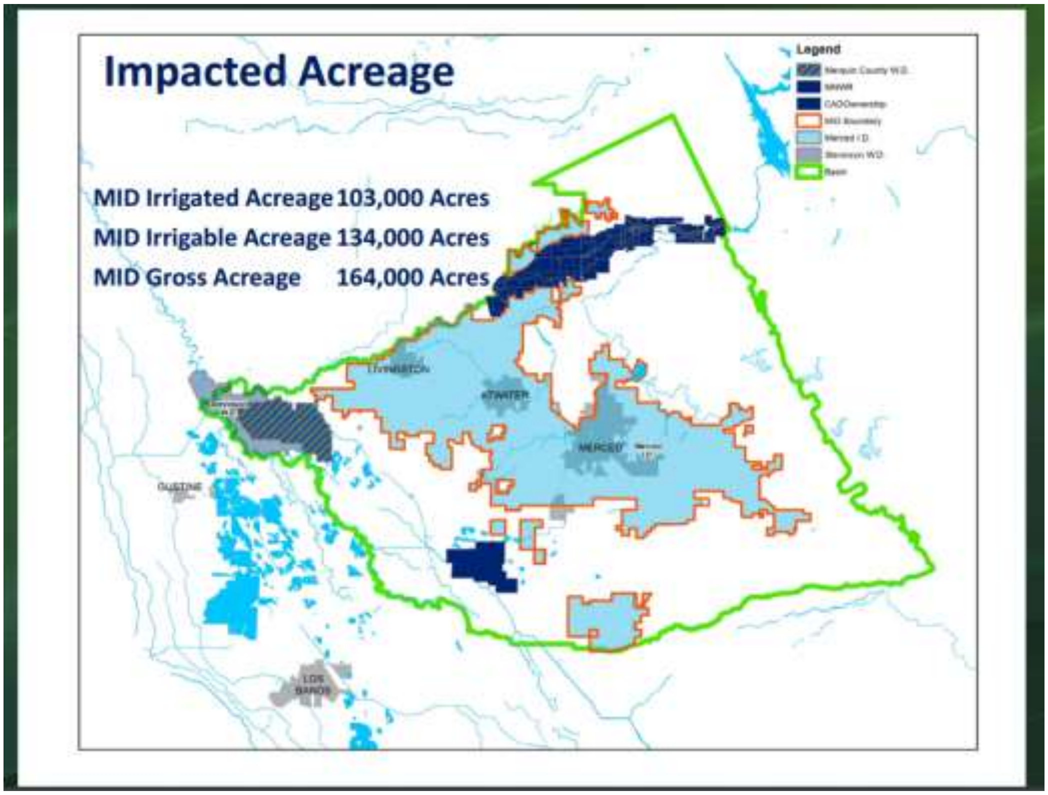

Overview
In 4th Year of an Unprecedented 4 Year Drought
January 2014 - State Of Emergency Declared By Governor Brown
February 4, 2014 - MID Board of Directors (BOD) Declares Local Drought Emergency
September 23, 2014 - MID BOD Reaffirms and Extends Declaration of Drought Emergency through end of 2015 Irrigation Season


Introduction
Review of MID Water Operations
Discuss Current Reservoir Conditions (Lake McClure)
2015 Water Management Implementation Plan Highlights
Public Outreach/Communication Plan


Review of MID Water Operations
Watershed and Schematic Water Balance
Total Outflows from Lake McClure Plus Water Distribution System Losses
– Merced River Releases Downstream (DS) of Crocker Huffman Diversion Dam (CHDD)
– MID Surface Water Diversions
MID Water Supply
– Storage Releases
– Lake McClure Inflows
– Supplemental Supplies
Reservoir Operations


Merced Irrigation District Watershed
Merced River Watershed Area
1,037 sq. miles
YOSEMITE NATIONAL PARK
MERCED
Successor in Interest to Water Entities Serving Irrigation Water Since 1870s
Serving Eastern Merced County for Almost 90 Years
Holds Riparian, Pre-1914 And Post 1914 Appropriative Water Rights

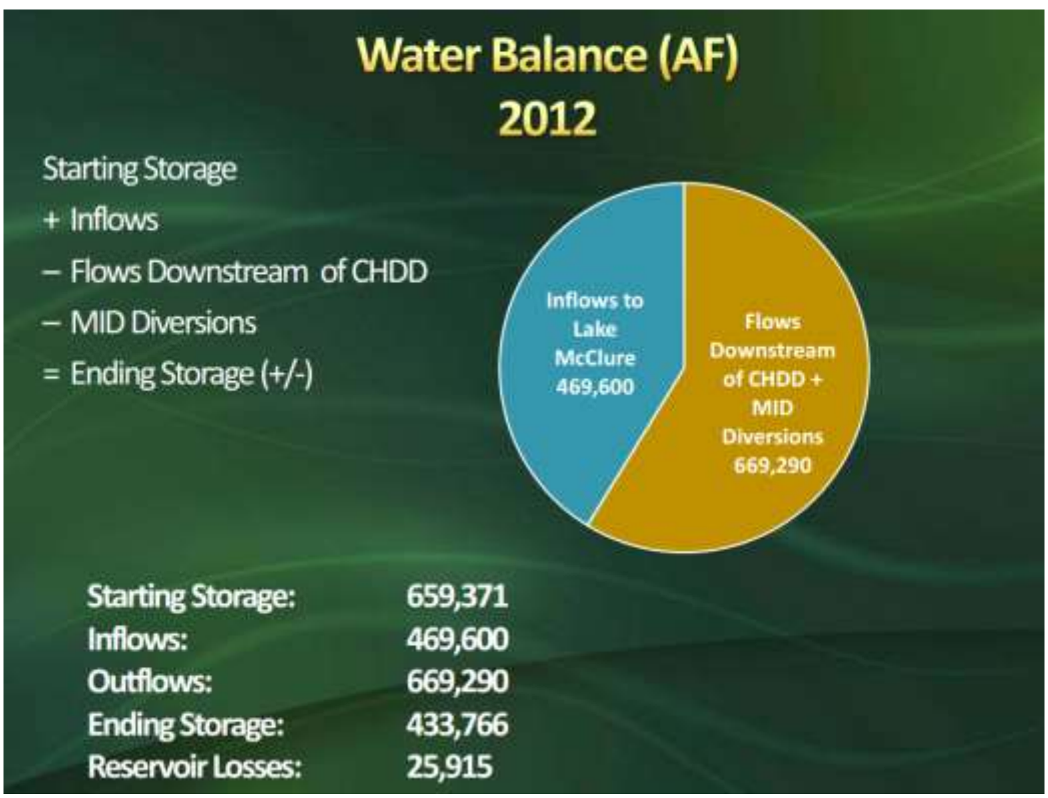

Schematic Water Balance
Starting Storage
+ Inflows
– Flows Downstream of CHDD
– MID Diversions
= Ending Storage (+/-)
Lake McClure Storage
Lake McClure
Lake McClure Inflows
Northside Canal Diversion
Merced River Releases DS of CHDD
Northside Canal
CADD Area
Lake McSwain
Main Canal
Main Canal Diversion
Supplemental Supplies
Escaladian Canal
Edendale Creek

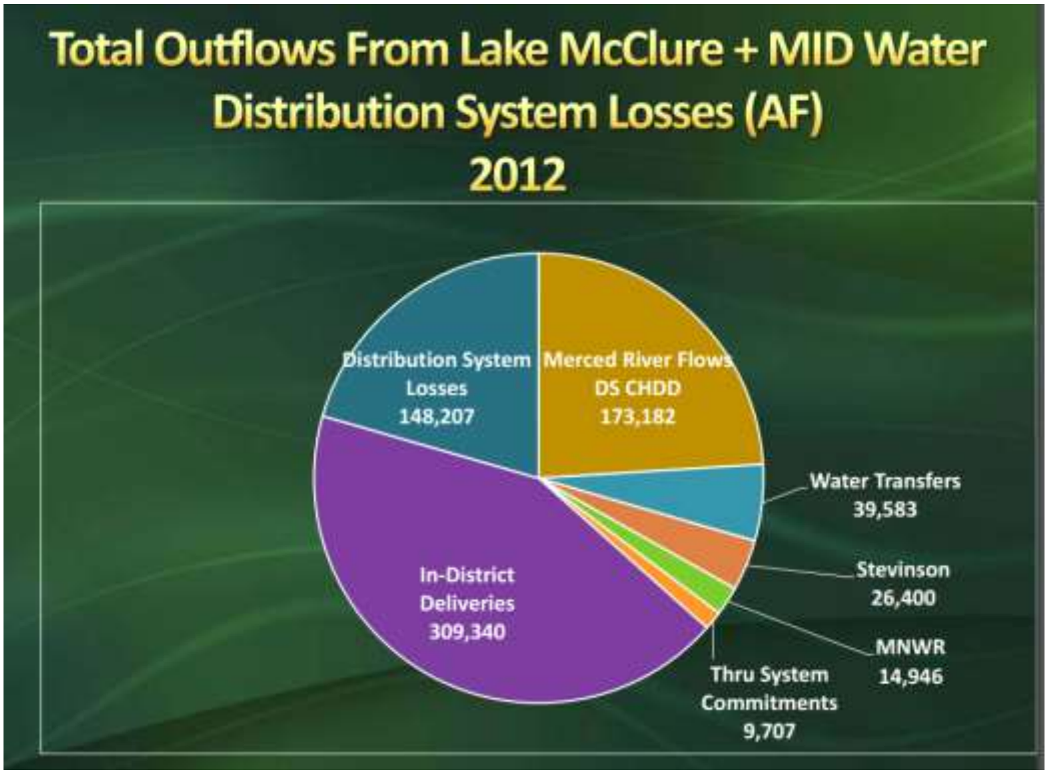


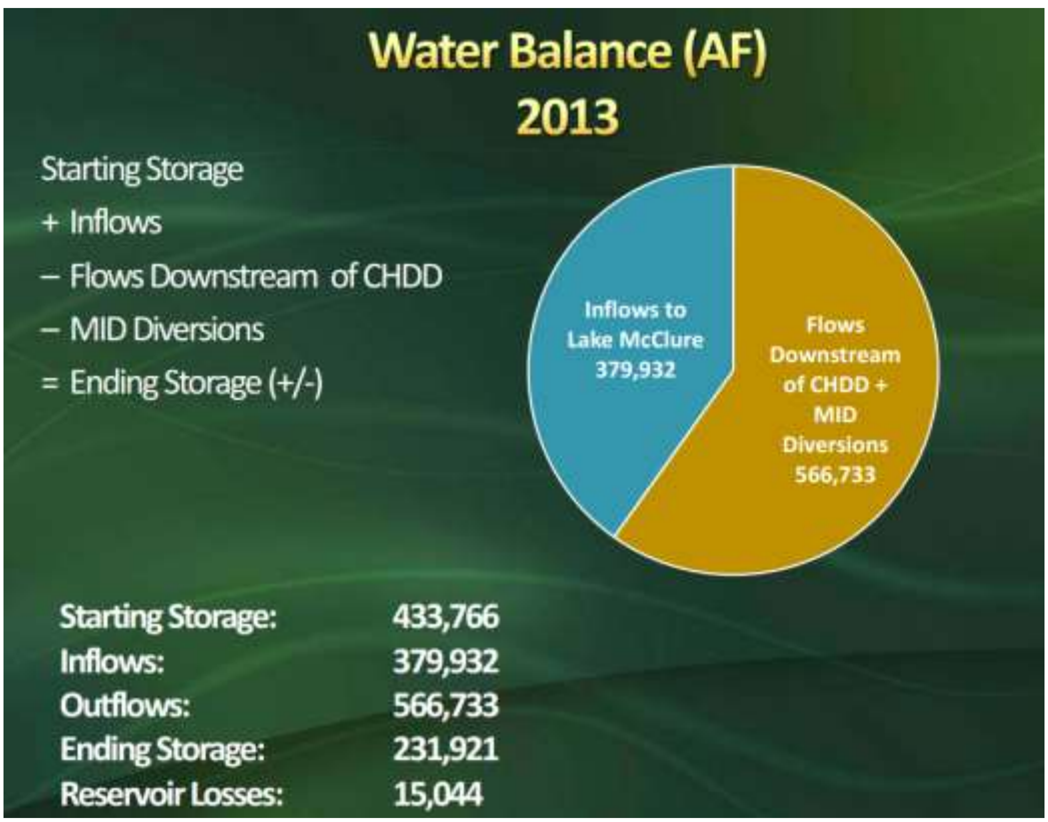
Merced River Releases DS of CHDD

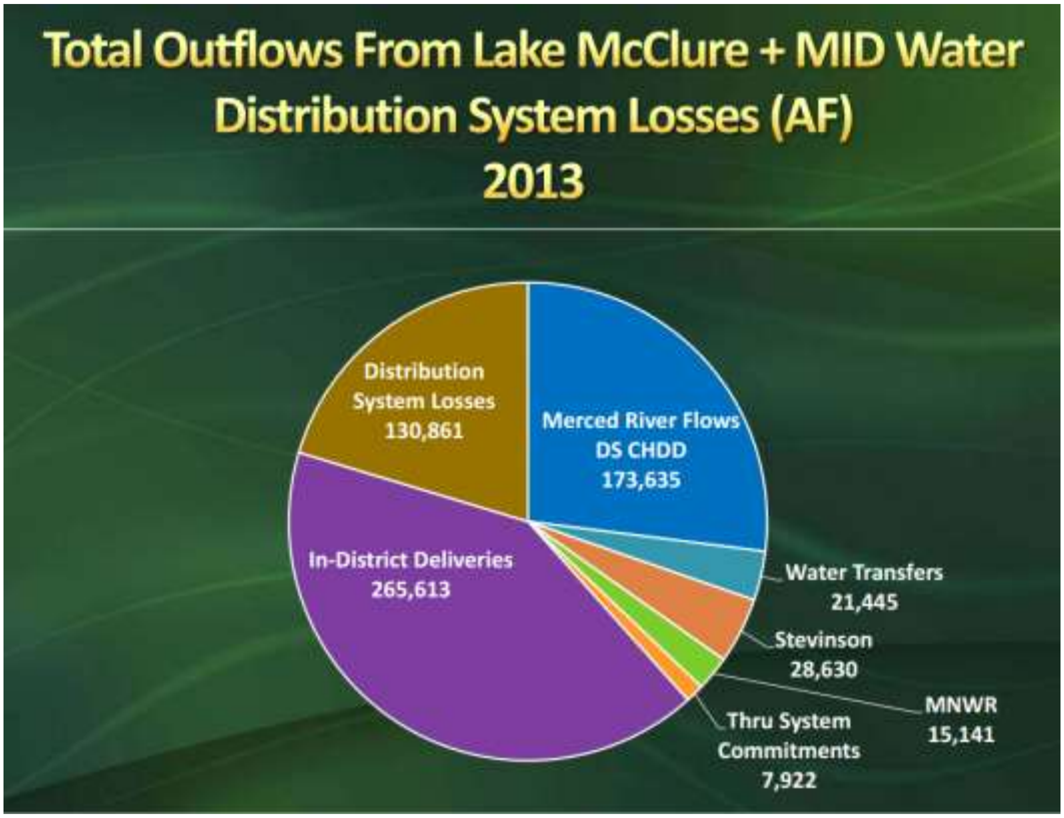
- **Instream Flow Requirements**
  - FERC
  - DWR Davis Grunsky
  - SWRCB Water Rights License
- **Other**
  - Flood Control Releases
  - Cowell Agreement Diverters (CAD) Flows
  - Riparian Diversions
  - Losses (seepage, buffer, evaporation, etc.)
- **Water Transfers**

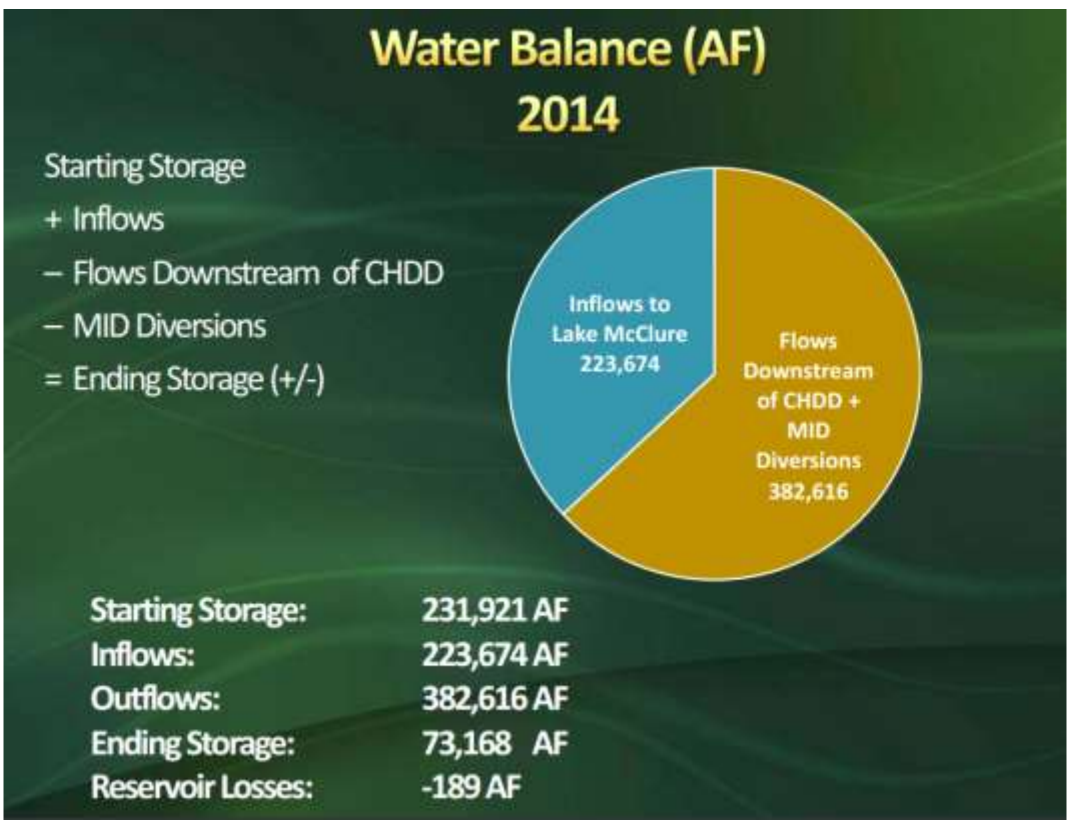

MID Surface Water Diversions
In-District Deliveries
Through System Commitments
– Stevinson Water District
– Merced National Wildlife Refuge
– Other
In-Basin Water Transfers (MID SOI Transfers, Refuges, etc.)
Losses (evaporation, seepage, other)

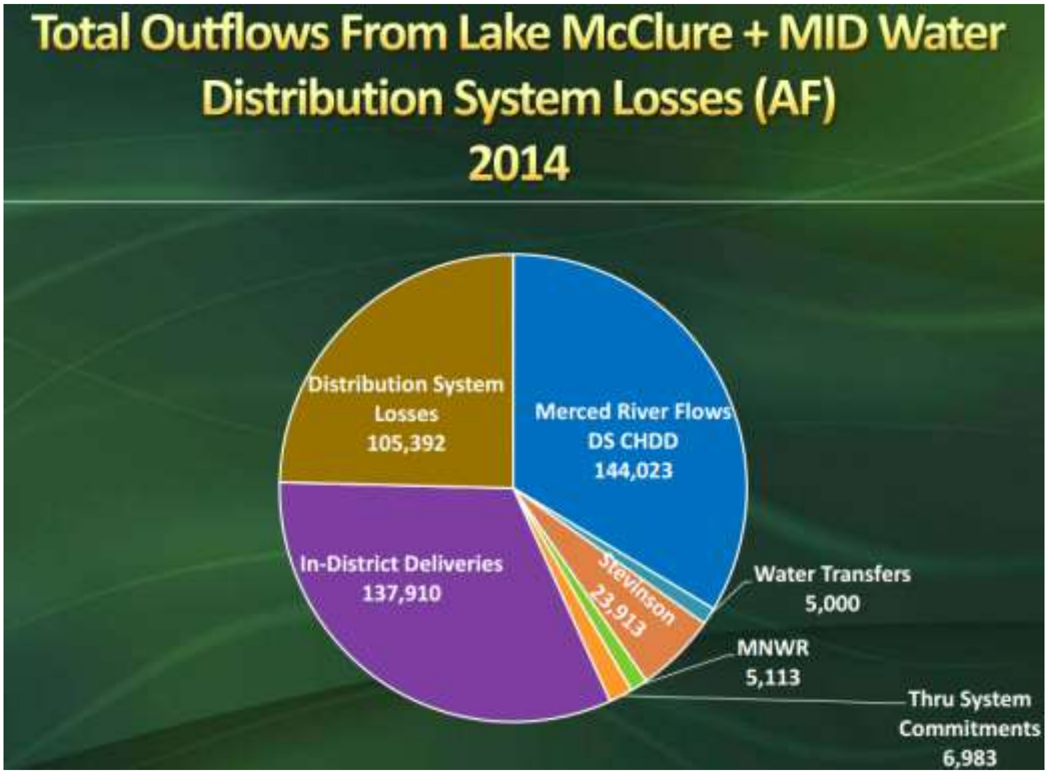

Water Balance (AF)
2012
Starting Storage
+ Inflows
– Flows Downstream of CHDD
– MID Diversions
= Ending Storage (+/-)
Inflows to Lake McClure 469,600
Flows Downstream of CHDD + MID Diversions 669,290
Starting Storage: 659,371
Inflows: 469,600
Outflows: 669,290
Ending Storage: 433,766
Reservoir Losses: 25,915

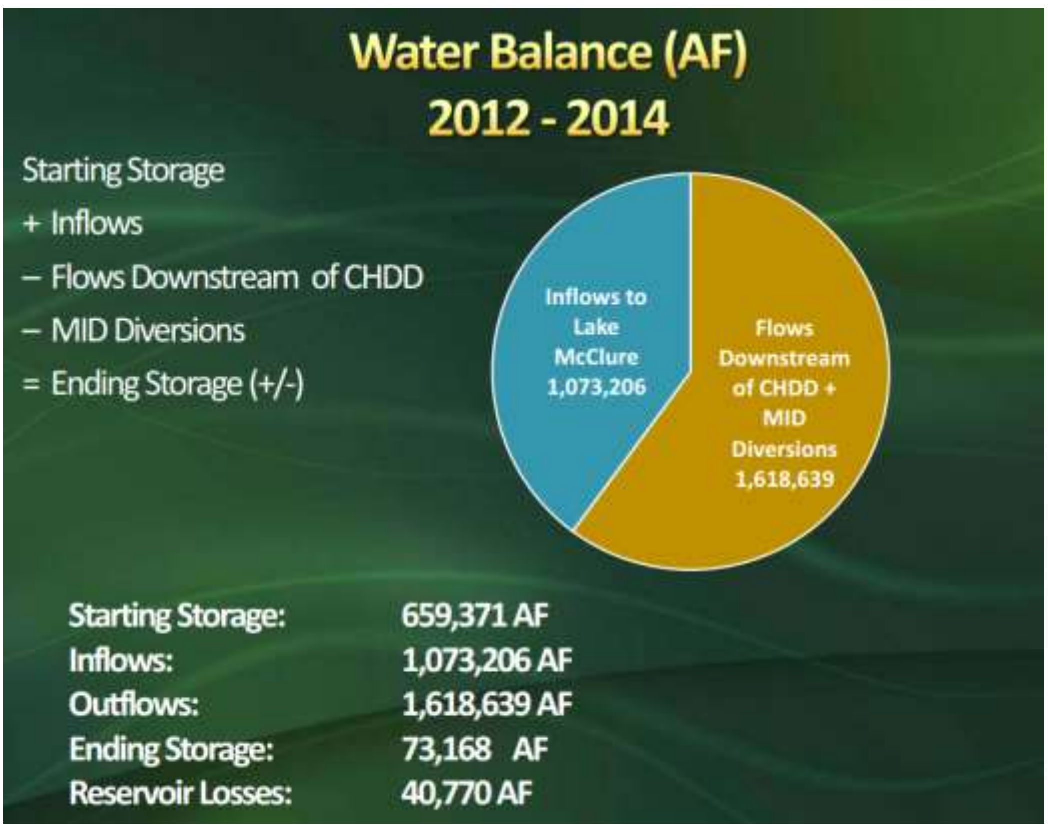

Total Outflows From Lake McClure + MID Water Distribution System Losses (AF)
2012
Distribution System Losses 148,207
Merced River Flows DS CHDD 173,182
Water Transfers 39,583
Stevinson 26,400
MNWR 14,946
Thru System Commitments 9,707
In-District Deliveries 309,340

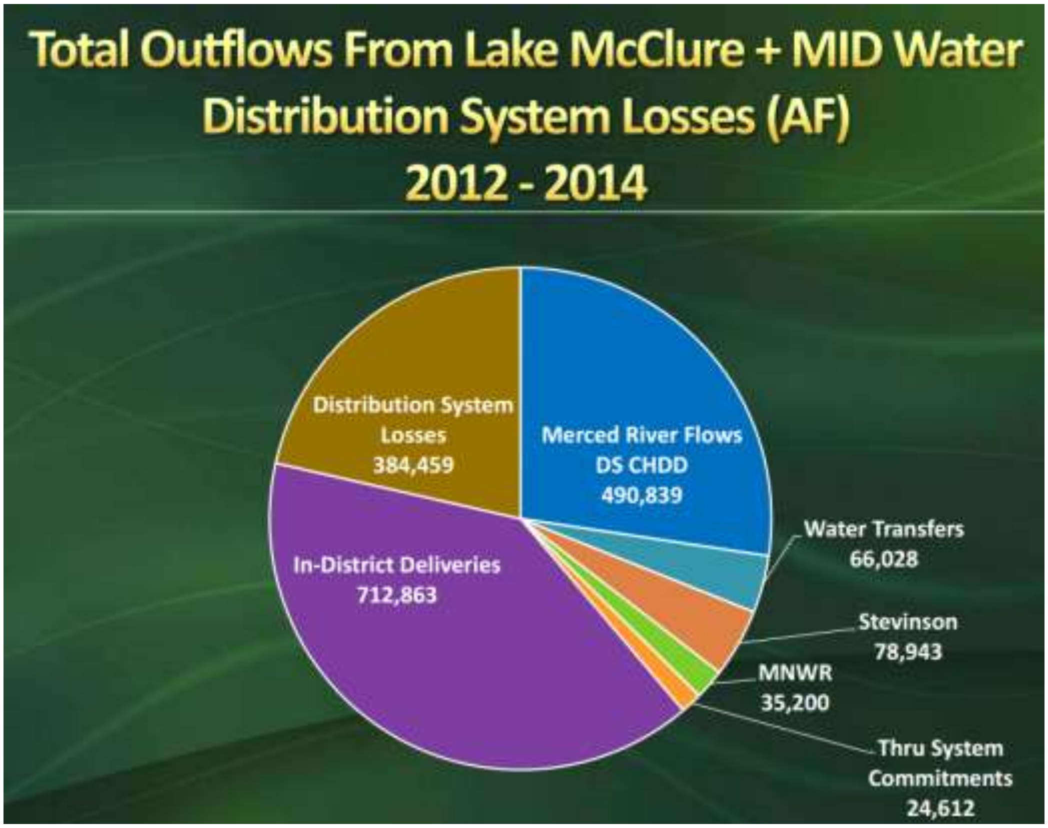

Water Balance (AF)
2013
Starting Storage
+ Inflows
– Flows Downstream of CHDD
– MID Diversions
= Ending Storage (+/-)
Inflows to Lake McClure 379,932
Flows Downstream of CHDD + MID Diversions 566,733
Starting Storage: 433,766
Inflows: 379,932
Outflows: 566,733
Ending Storage: 231,921
Reservoir Losses: 15,044


Total Outflows From Lake McClure + MID Water Distribution System Losses (AF)
2013
Distribution System Losses 130,861
Merced River Flows DS CHDD 173,635
In-District Deliveries 265,613
Water Transfers 21,445
Stevinson 28,630
MNWR 15,141
Thru System Commitments 7,922


Water Balance (AF)
2014
Starting Storage
+ Inflows
– Flows Downstream of CHDD
– MID Diversions
= Ending Storage (+/-)
Inflows to Lake McClure 223,674
Flows Downstream of CHDD + MID Diversions 382,616
Starting Storage: 231,921 AF
Inflows: 223,674 AF
Outflows: 382,616 AF
Ending Storage: 73,168 AF
Reservoir Losses: -189 AF


Total Outflows From Lake McClure + MID Water Distribution System Losses (AF)
2014
Distribution System Losses 105,392
Merced River Flows DS CHDD 144,023
In-District Deliveries 137,910
Stevinson 23,913
Water Transfers 5,000
MNWR 5,113
Thru System Commitments 6,983

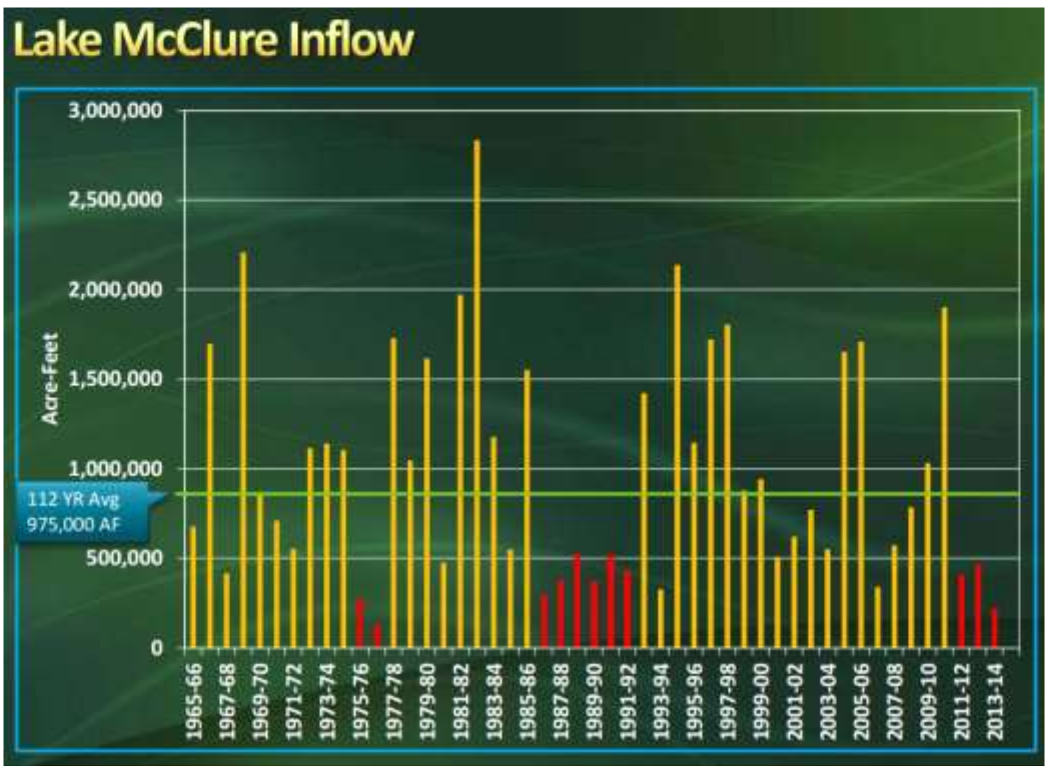

Water Balance (AF)
2012 - 2014
Starting Storage
+ Inflows
– Flows Downstream of CHDD
– MID Diversions
= Ending Storage (+/-)
Inflows to Lake McClure 1,073,206
Flows Downstream of CHDD + MID Diversions 1,618,639
Starting Storage: 659,371 AF
Inflows: 1,073,206 AF
Outflows: 1,618,639 AF
Ending Storage: 73,168 AF
Reservoir Losses: 40,770 AF



MID In-District Deliveries Applied Acreage

	2011	2012	2013	2014	2015
Irrigated Acreage	97,415	104,480	101,802	87,989	TBD
Acre-Feet Delivered	263,194	309,340	265,613	137,910	TBD
AF/Acre Delivered	2.7	3.0	2.6	1.6	TBD


Current Reservoir Status


Lake McClure Inflow
Acre-Feet
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
112 YR Avg
975,000 AF
1965-66
1967-68
1969-70
1971-72
1973-74
1975-76
1977-78
1979-80
1981-82
1983-84
1985-86
1987-88
1989-90
1991-92
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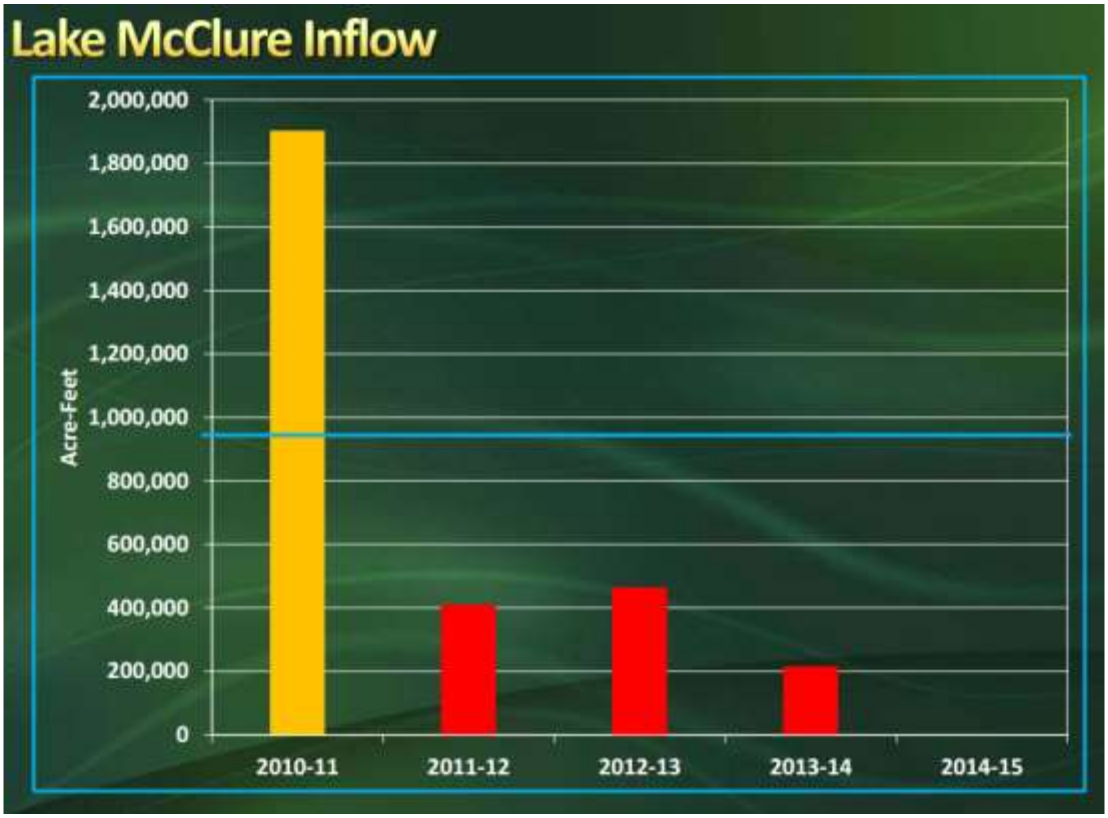
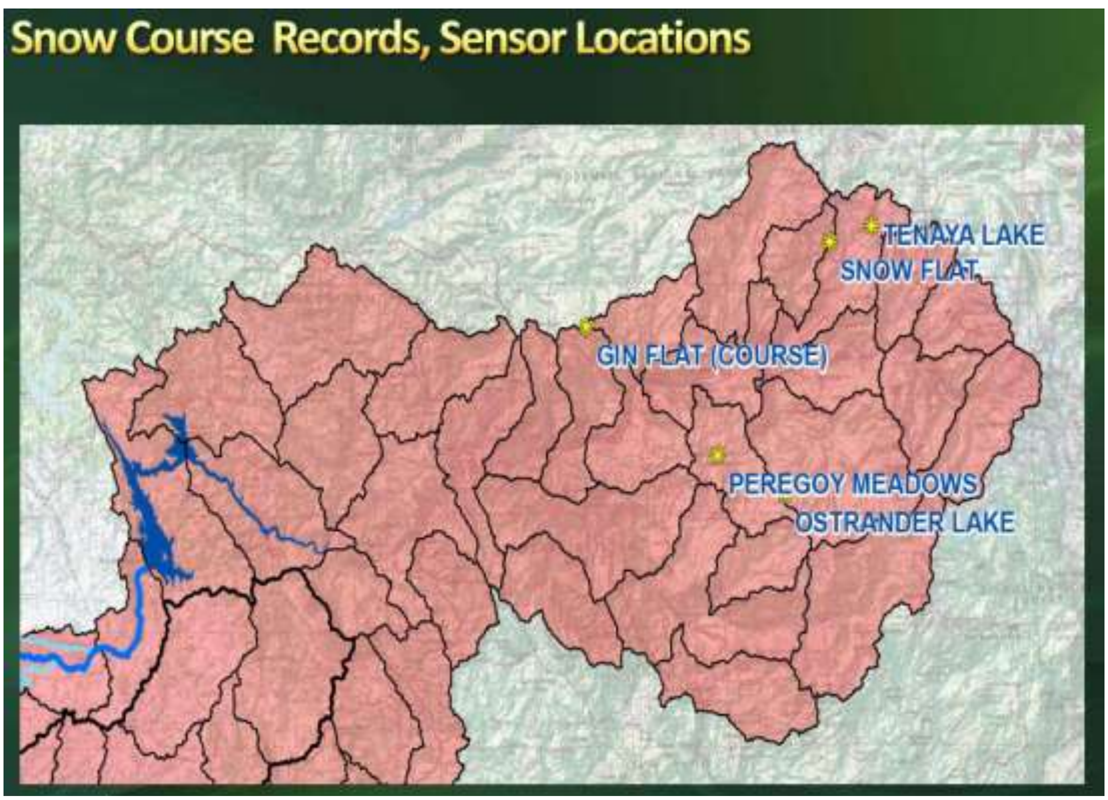
2005-06
2007-08
2009-10
2011-12
2013-14

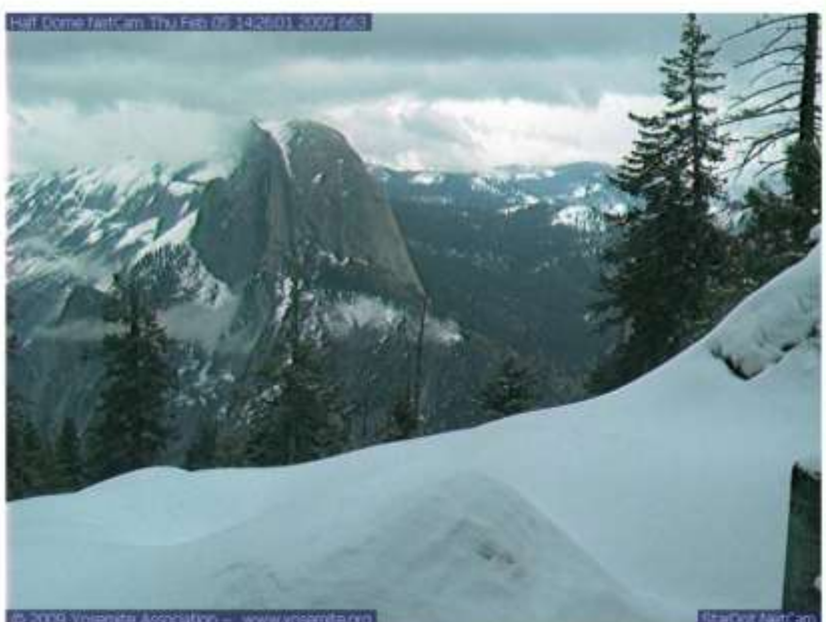

Lake McClure Inflow
Acre-Feet
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
2010-11
2011-12
2012-13
2013-14
2014-15


Snow Course Records, Sensor Locations
TENAYA LAKE
SNOW FLAT
GIN FLAT (COURSE)
PEREGOY MEADOWS
OSTRANDER LAKE

Snow Water Content – Inches

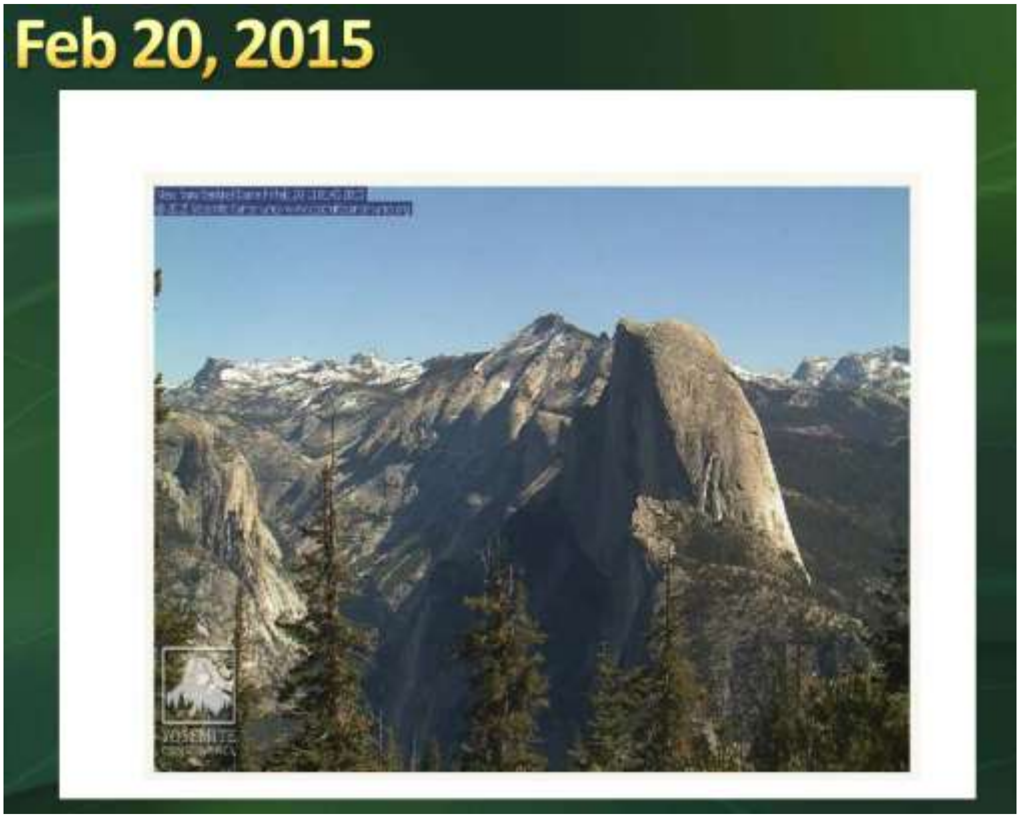
Station	Elevation (Feet)	Snow Depth, Water Equivalent, Inches			
		Feb 2 2015	Feb 20 2015	APR 1 Avg.	% APR 1st Avg.
GIN FLAT	7,050	3.5	<1	32.0	3%
TENAYA LAKE	8,150	4.0	Not Reporting	33.6	12%
OSTRANDER LAKE	8,200	7.5	7.5	32.6	23%

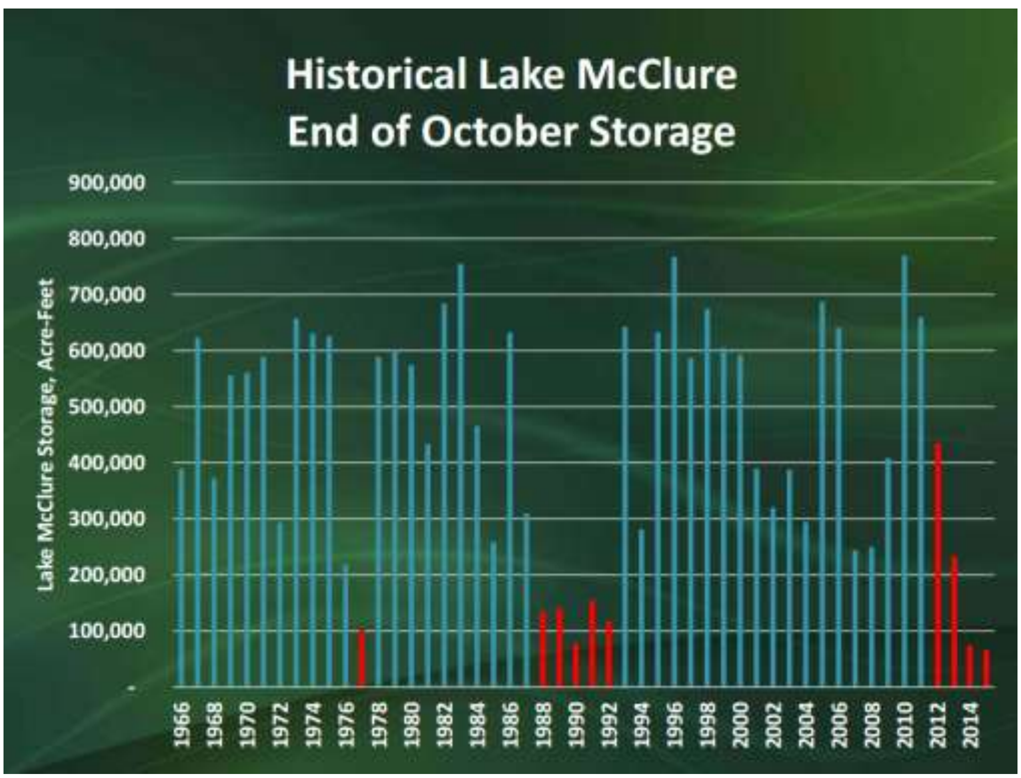
Feb 5, 2009 Below Normal Year

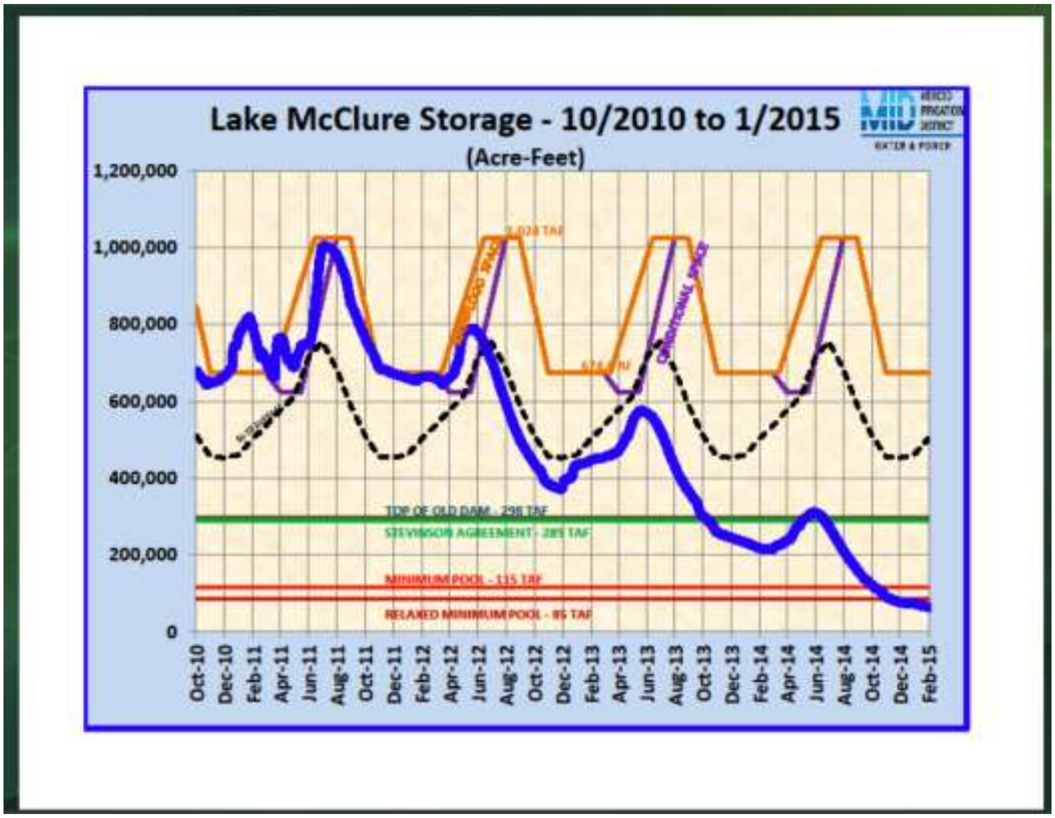


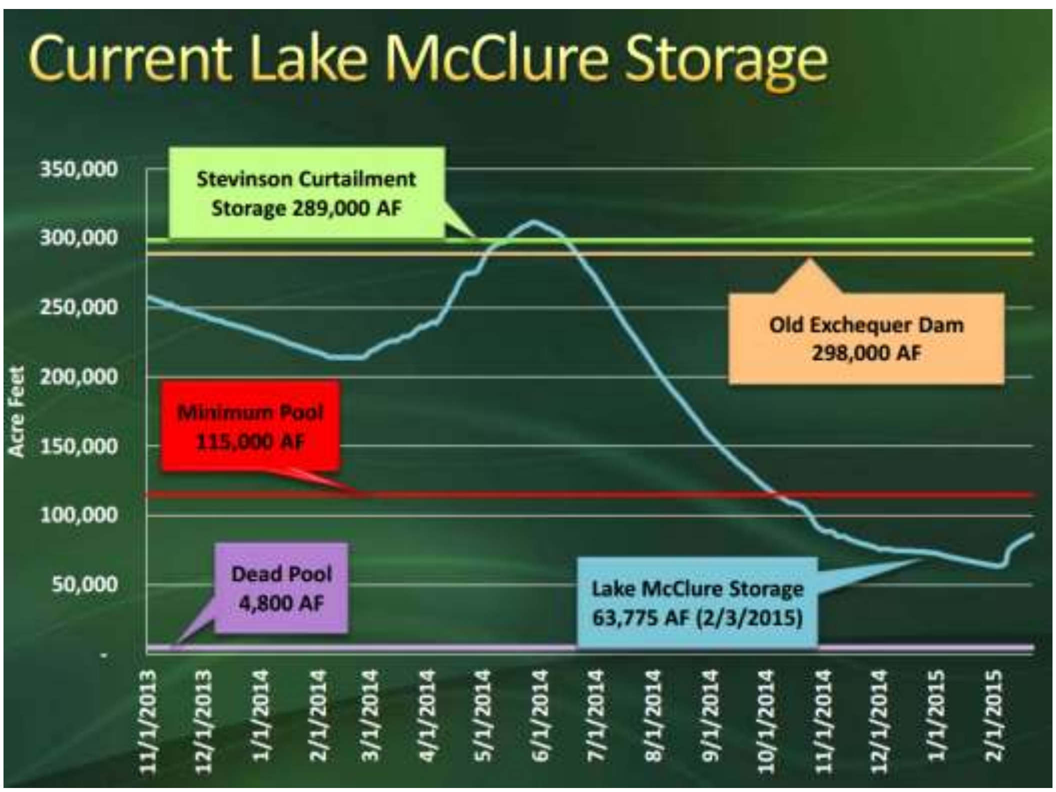

Jan 5, 2011
Wet Year


Feb 1, 2015
YOSEMITE


Feb 20, 2015


Historical Lake McClure
End of October Storage
Lake McClure Storage, Acre-Feet
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Lake McClure Storage - 10/2010 to 1/2015
(Acre-Feet)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14
Feb-15

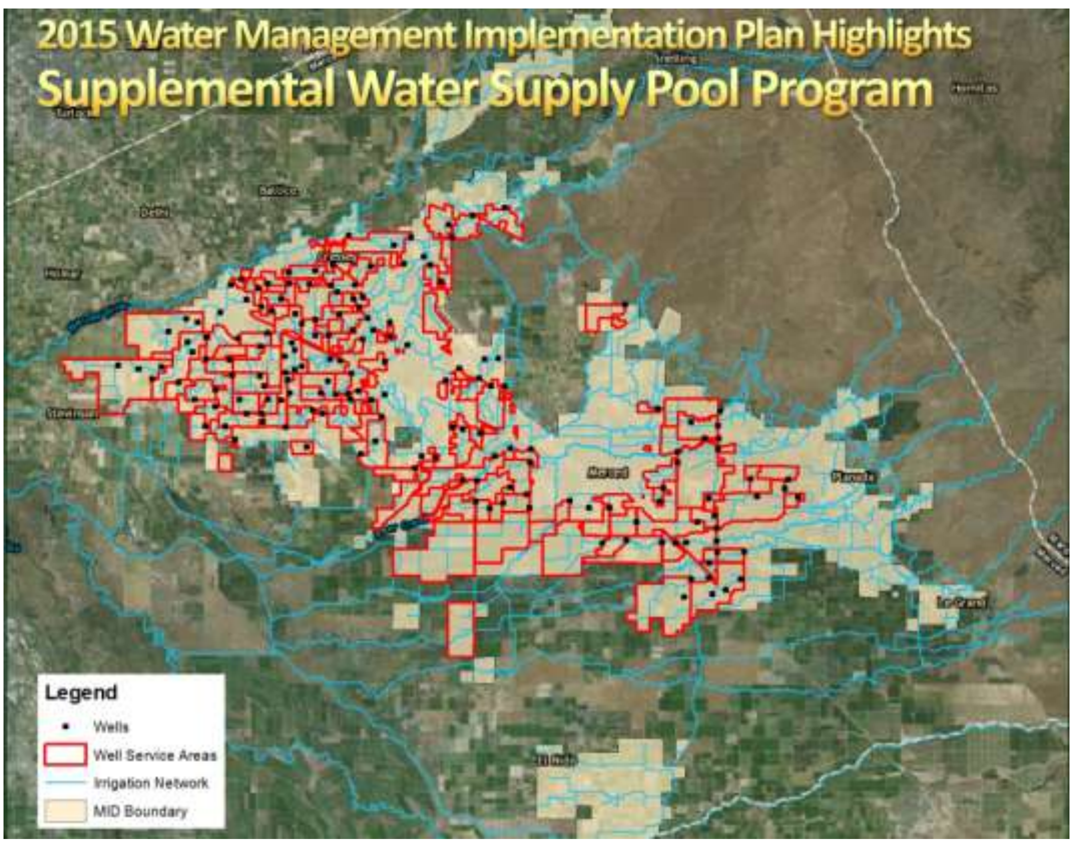

Current Lake McClure Storage
Acre Feet
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
Stevinson Curtailment Storage 289,000 AF
Old Exchequer Dam 298,000 AF
Minimum Pool 115,000 AF
Dead Pool 4,800 AF
Lake McClure Storage 63,775 AF (2/3/2015)
11/1/2013
12/1/2013
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
10/1/2014
11/1/2014
12/1/2014
1/1/2015
2/1/2015


2015 Water Management
Implementation Plan Highlights


Overview
In 4th Year of an Unprecedented 4 Year Drought
January 2014 - State Of Emergency Declared By Governor Brown
February 4, 2014 - MID Board of Directors (BOD) Declares Local Drought Emergency
September 23, 2014 - MID BOD Reaffirms and Extends Declaration of Drought Emergency through end of 2015 Irrigation Season


2015 Water Management Implementation Plan Highlights
Limited Availability to Supplemental Water Supply Pool Program ("Program") in 2015
– Made Available by Conjunctive Groundwater Pumping (Supplemental Supplies)
Private Groundwater Wheeling
Currently, No Available Surface Water Supply for 2015
– Currently, No Storage Available for MID Diversion from Lake McClure
– Subject to Change Based on Future Hydrology
– Wait for March/April Hydrology to Develop

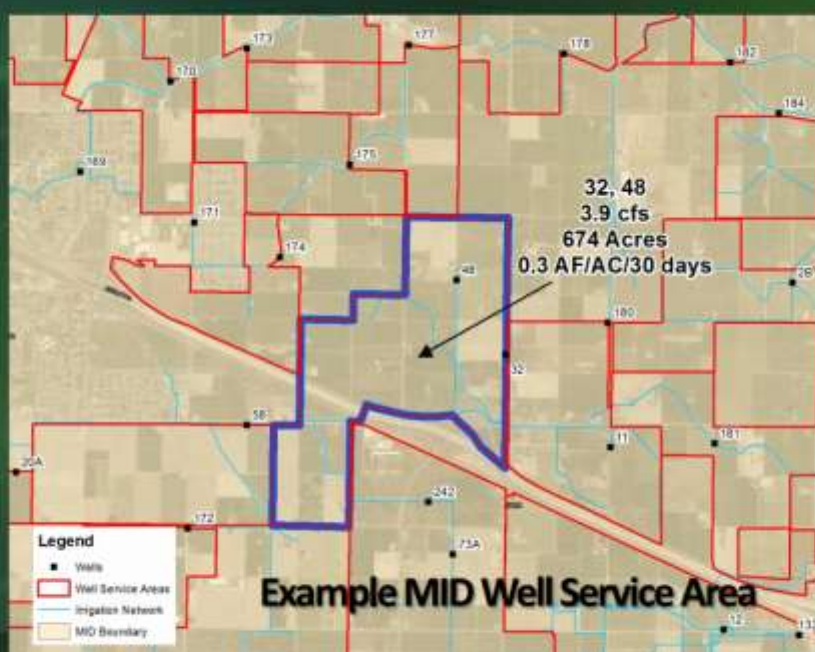

2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
Availability Based on Location of Parcel and Availability of MID Well Service
– Limited Availability Due to the Reliance on Direct Diversions and No Stored Surface Water Available for Diversion
– Turnout Must be Located on MID Facilities Downstream of Existing MID Groundwater Wells
112 Well Service Areas (WSA) Have been Developed
Potential Supplemental Supply Capacities of WSAs Based on Existing Operational MID Wells
No Guarantees Can Be Made Regarding Their Continued Operational Status (Update on MID Well Field Evaluation Presented Below)

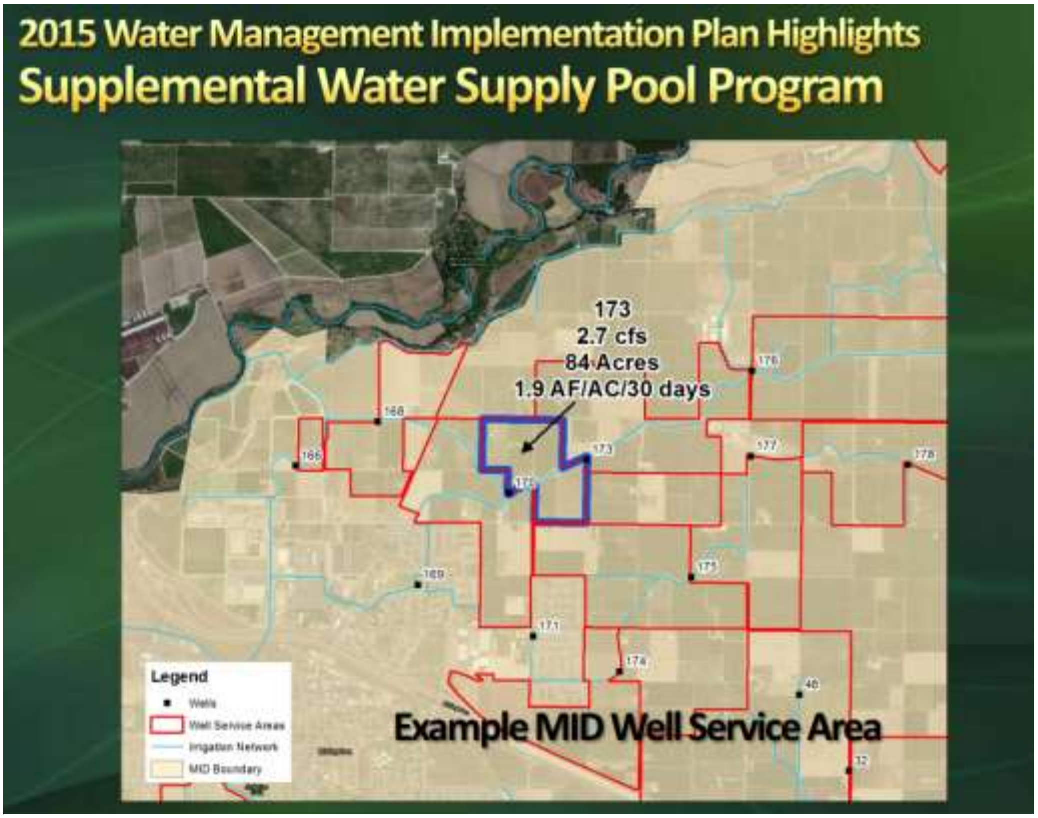

2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
Legend
Wells
Well Service Areas
Irrigation Network
MID Boundary

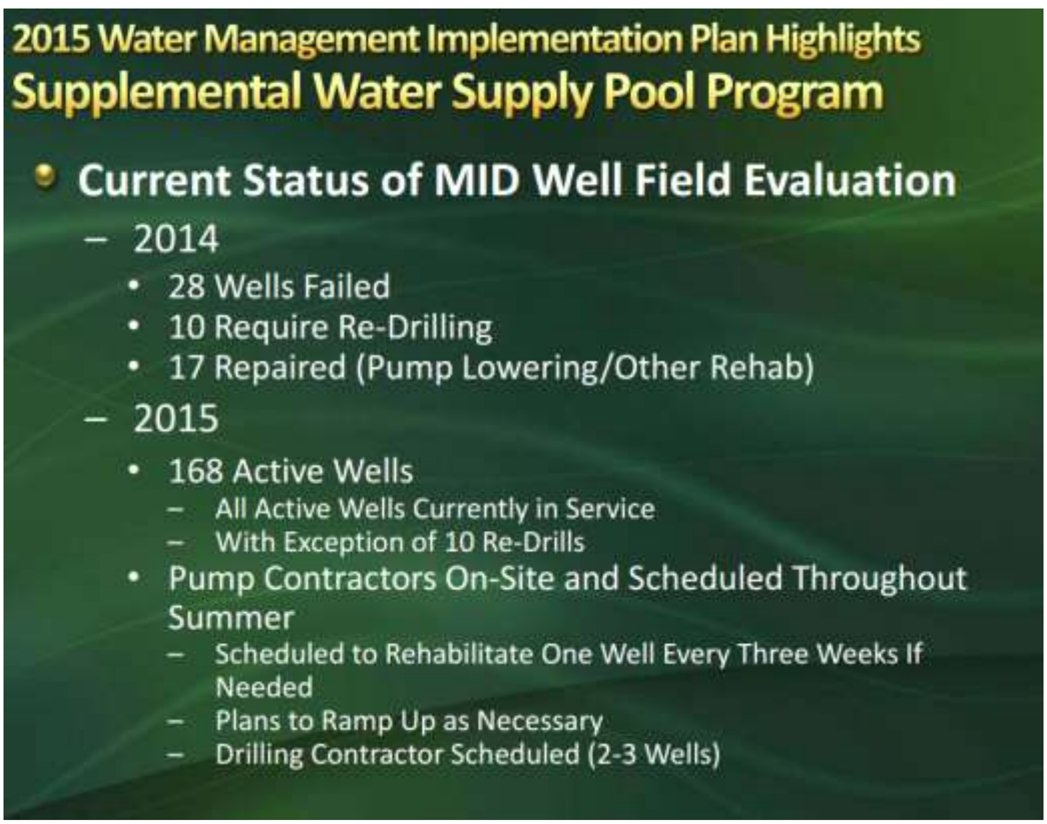
2015 Water Management Implementation Plan Highlights
Parcel Access to Supplemental Water Supply Pool Program

Crop	MID Well Service Areas (Acres)		
	No	Yes	Total
Annual	19,700	26,300	46,000
Permanent	28,200	29,000	57,200
Totals	**47,900**	**55,300**	**103,200**

2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program



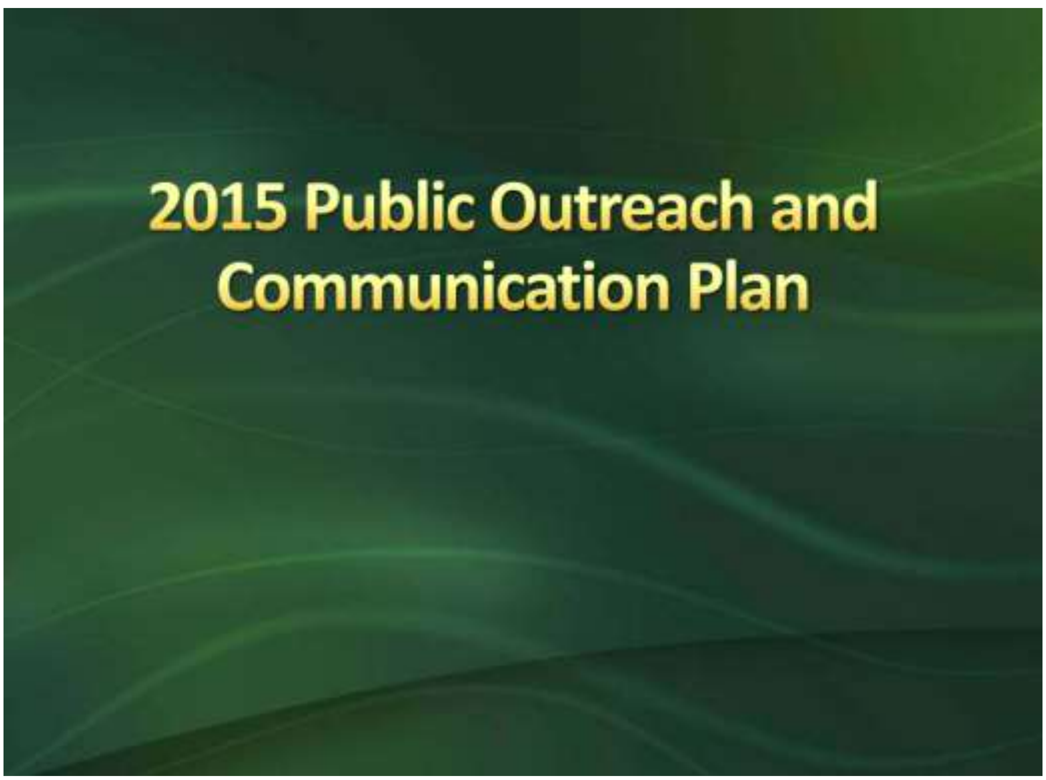

2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
173
2.7 cfs
84 Acres
1.9 AF/AC/30 days
Legend
Wells
Well Service Areas
Irrigation Network
MID Boundary
Example MID Well Service Area


2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
Current Status of MID Well Field Evaluation
– 2014
• 28 Wells Failed
• 10 Require Re-Drilling
• 17 Repaired (Pump Lowering/Other Rehab)
– 2015
• 168 Active Wells
– All Active Wells Currently in Service
– With Exception of 10 Re-Drills
• Pump Contractors On-Site and Scheduled Throughout Summer
– Scheduled to Rehabilitate One Well Every Three Weeks If Needed
– Plans to Ramp Up as Necessary
– Drilling Contractor Scheduled (2-3 Wells)


2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
Out-of-Season Conjunctive Groundwater
– Available Through March 31, 2015
Supplemental Water Supply Pool Program to Begin April 1
– Applications for Service Due No Later than March 20, 2015
– Program Pricing Likely to be in Excess of $205/AF
• Meeting Debt Covenant Requirement
– 2015 First FERC Relicensing Debt Payment Due
• Financial Reserve Policy Considerations – Preparing for Potential 5th Drought Year
• $50/Acre Prepayment Required at Time of Application
• Per/AF Price Will be Set No Later than April 1, 2015 as Part of the FY 2015/2016 Budget Adoption


2015 Water Management Implementation Plan Highlights
Supplemental Water Supply Pool Program
Cannot Guarantee Program Water Availability Either by Frequency, Rate or Duration
Deliveries Will Likely be on Rotation Basis
Supplemental Supplies Will Likely be Inadequate to Grow Full Crop of Any Kind in Most Well Service Areas
Must Submit an Application to Be Eligible for Program Supplies (due March 20th)
– Fill Out Right After Meeting
– Download Application from www.mercedid.org
– Will Be Mailed to Eligible Parcel Owners
– Obtain and/or Complete at Water Operations Area Grower Meetings


2015 Water Management Implementation Plan Highlights
Private Groundwater Wheeling
No Daily Wheeling Fee
Temporary Modifications to District Facilities for Wheeling Purposes
– Considered on a Case by Case Basis
– Temporary Pump Permit Required (fee waived)
– All Temporary Infrastructure Costs Borne by Applicant


2015 Public Outreach and Communication Plan

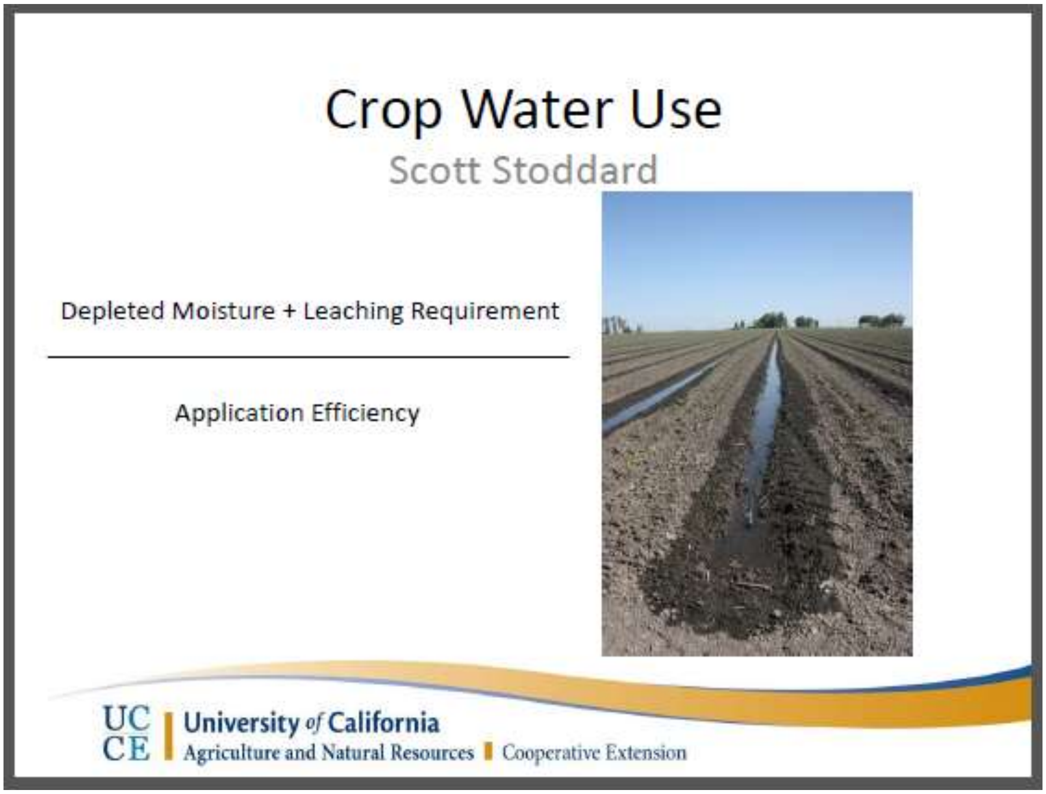
2015 Public Outreach and Communication Plan

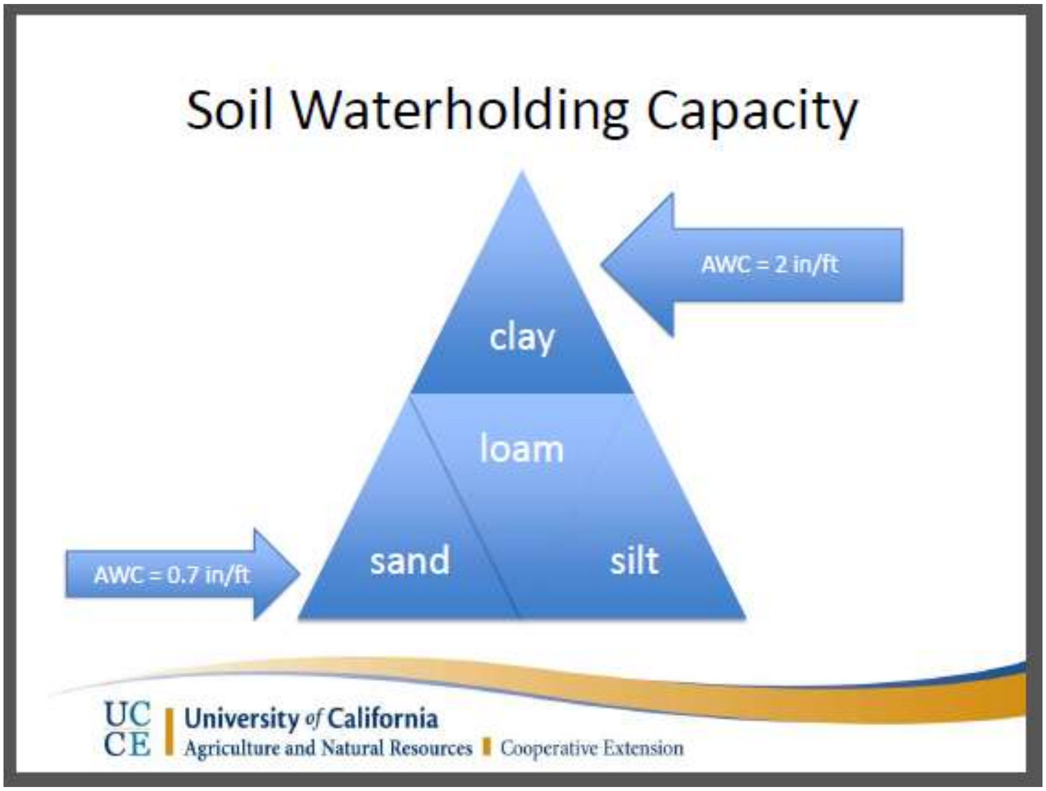
Activity	Comment
Board Meetings	Activities Discussed on Following Slides
Press Releases	
Letters to Growers	
"Drought Watch" Web Page	
Grower Meetings	
Customer Service	
DSOs	

2015 Public Outreach and Communication Plan Short Term Scheduled Activities

Date	Activity
2/26/2015	Press Release
2/26/2015	Letter to Growers
3/3/2015	Board Meeting
3/17/2015	Board Meeting
3/25/2015	**Grower Meeting**
TBD	**MID Irrigation Operations Area Grower Meetings in WSAs**

UC Cooperative Extension in Merced technical Presentation to Growers





Plant Available Water

	Clay (Merced)	Silt (Le Grand)	Sand (Atwater)
AWC, in/ft	2	1.5	0.75
Root zone, ft (crop)	3	3 - 4	3 - 4
Allowed depletion	50%	50%	50%
TOTAL PAW	3 in	3 in	1.5 in

Pre-irrigation > 6″ will exceed soil capacity to hold the water!

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Leaching Requirement

Provided the water is of reasonable quality, leaching of salts may be postponed in drought years.

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IRRIGATION WATER QUALITY
General limit of vegetable crop tolerance :

	Irrigation water content			
	Na	Cl	B	E.C./TDS
No restriction	< 115 PPM or 5 meq/liter	< 100 PPM or 3 meq/liter	< 0.5 ppm	< 0.75 mmhos/cm or 480 ppm
Severe restriction	> 460 PPM or 20 meq/liter	> 350 PPM or 10 meq/liter	> 2 ppm	> 3.0 mmhos/cm or 1920 ppm

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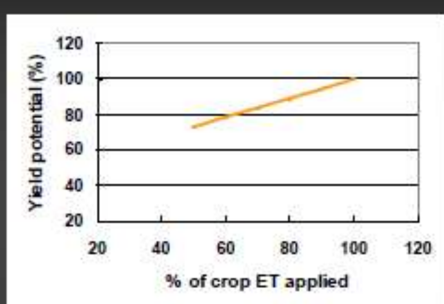
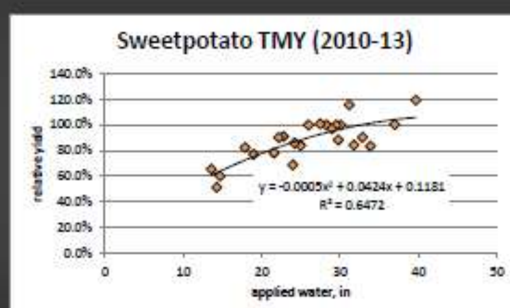
What about deficit irrigation ?

Melon tolerance for deficit irrigation:



Adapted from Cabello et al. (2009) and Fabreiro et al. (2002); deficit applied across entire season



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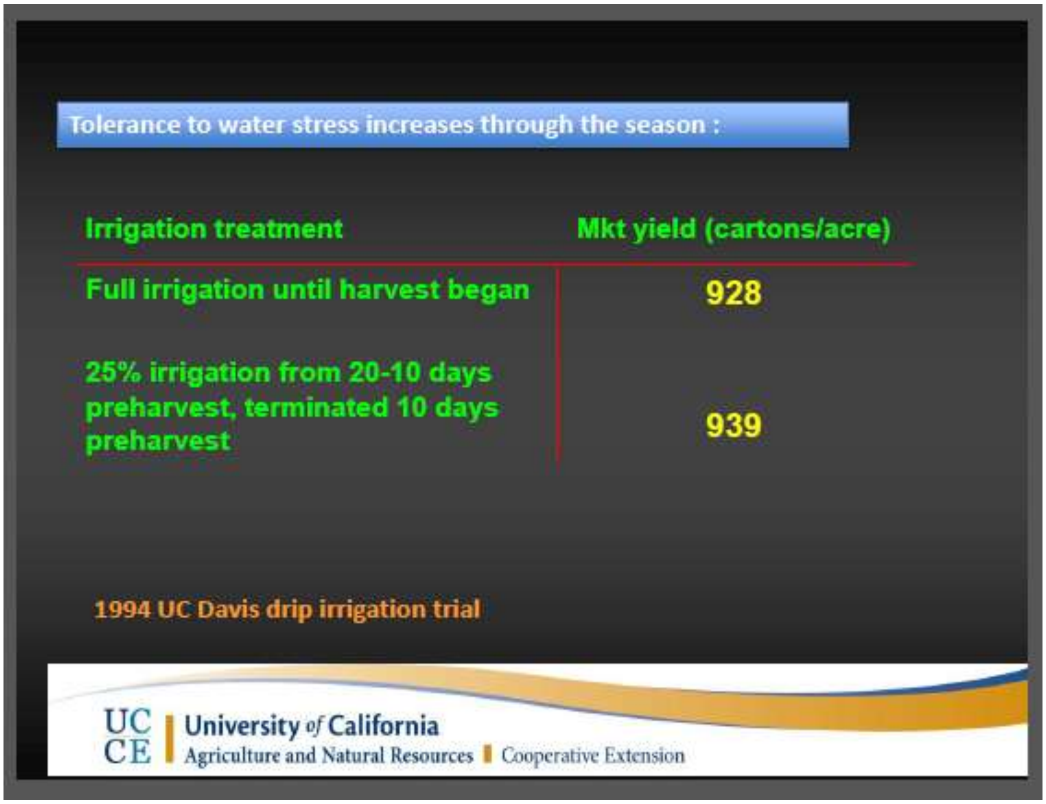
Tolerance to water stress increases through the season :
Irrigation treatment
Mkt yield (cartons/acre)
Full irrigation until harvest began
928
25% irrigation from 20-10 days preharvest, terminated 10 days preharvest
939
1994 UC Davis drip irrigation trial
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Cooperative Extension


Silver lining to melon stress – improved firmness and soluble solids
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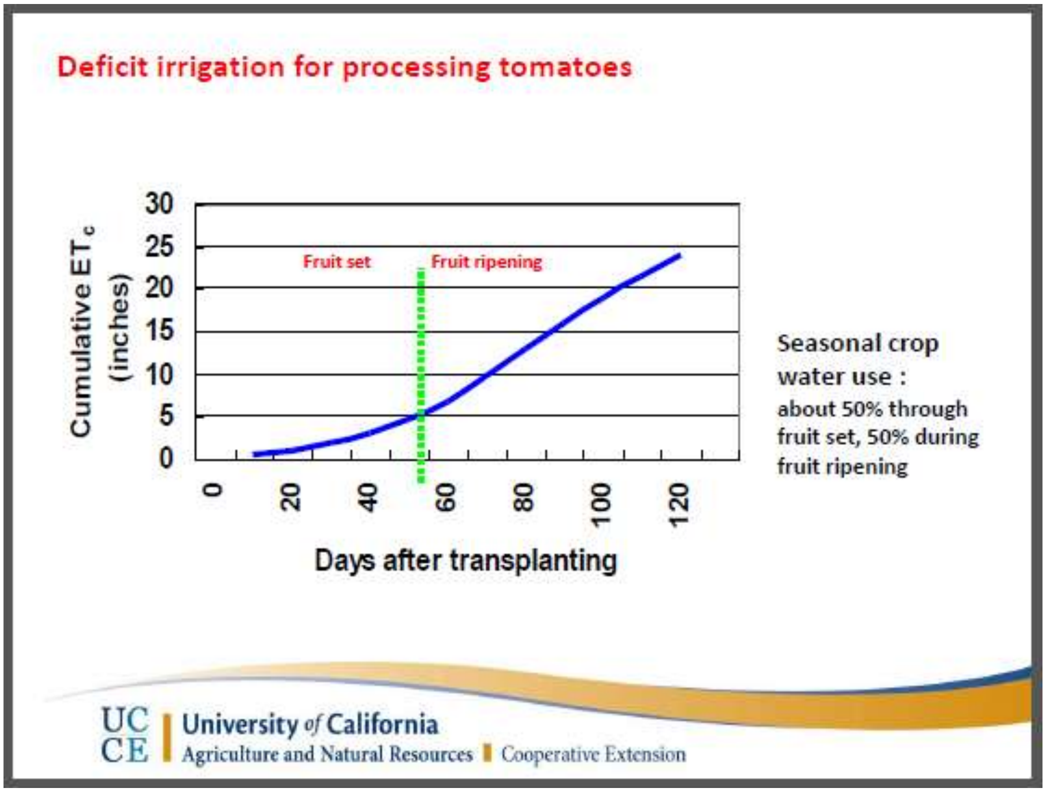
Cooperative Extension


Deficit irrigation for processing tomatoes
Cumulative ETc (inches)
30
25
20
15
10
5
0
Fruit set
Fruit ripening
0
20
40
60
80
100
120
Days after transplanting
Seasonal crop water use :
about 50% through fruit set, 50% during fruit ripening
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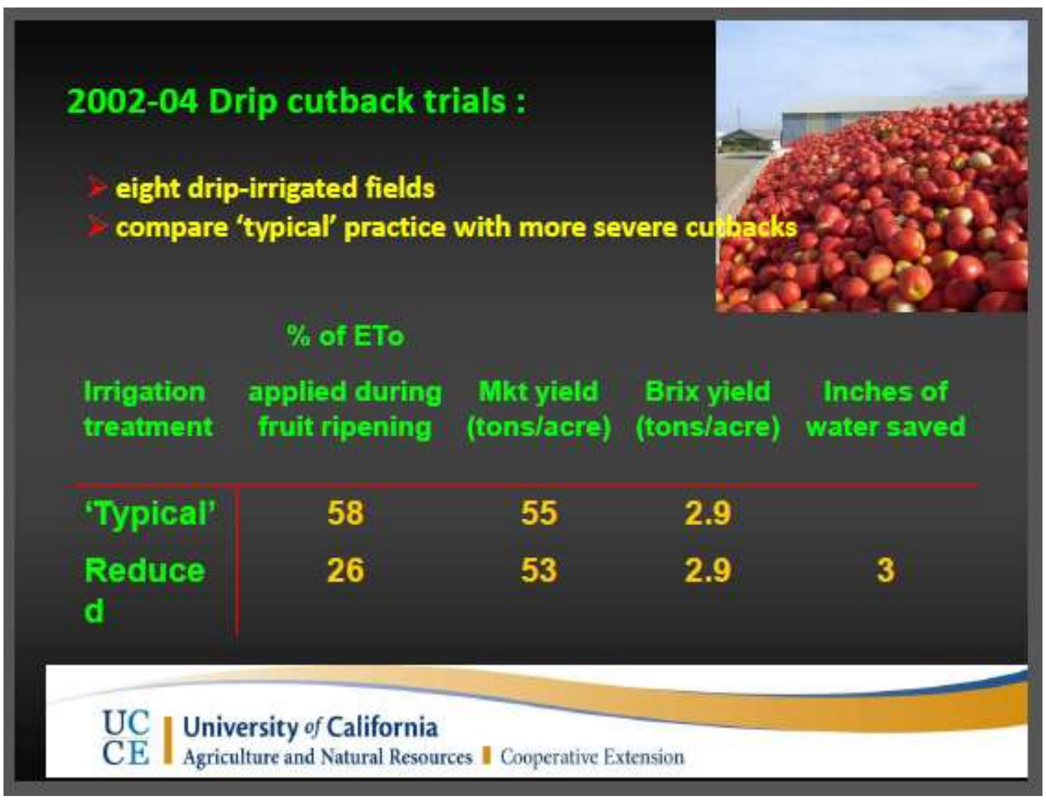
2002-04 Drip cutback trials :
eight drip-irrigated fields
compare 'typical' practice with more severe cutbacks
Irrigation treatment
% of ETo applied during fruit ripening
Mkt yield (tons/acre)
Brix yield (tons/acre)
Inches of water saved
'Typical' 58 55 2.9
Reduced 26 53 2.9 3
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In summary :
vegetable crops differ in their sensitivity to salinity and water stress
salinity is more a concern over seasons than within seasons
specific ion toxicity a minimal threat in most cases
water stress tolerance increases over the season. Reduce water late, not early.
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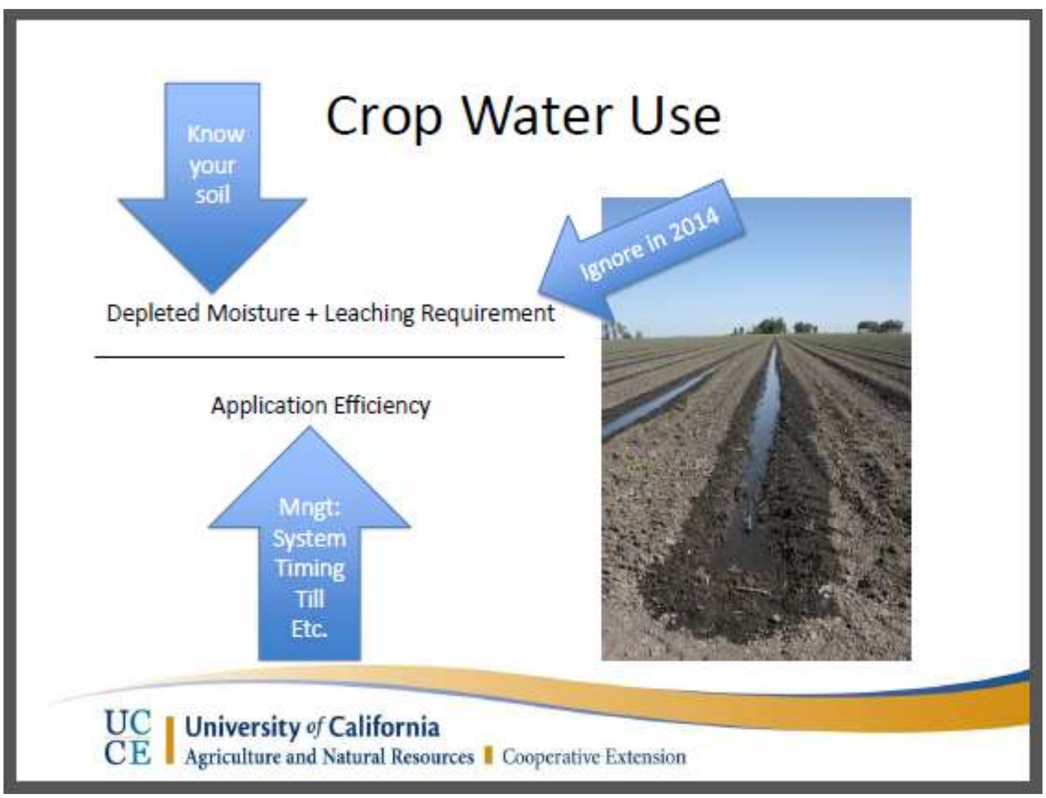
Crop Water Use
Know your soil
Ignore in 2014
Depleted Moisture + Leaching Requirement
Application Efficiency
Mngt: System Timing Till Etc.
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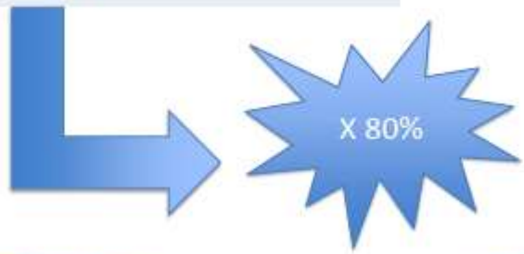
Water use on annual crops can be reduced and maintain reasonable yields

Crop	Inches/A
Tomatoes	24 - 28
Sweetpotatoes	28 - 30
Cotton	24 - 30
Small grains	12 - 24



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UC ANR

Drought Management for Grapes and Stone Fruit

Maxwell Norton

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Permanent crops

Know what is down there

Go deeper than a shovel

Don't irrigate just because you think you should

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Grapes

Spray out or closely mow cover crops or weeds

Use herbicides to control weeds on berm

If non-cultivation, do not disc – preserve surface roots

Drip: apply less often but deeper irrigations to reduce total time that soil surface is wet

Reduce fertilizer

Be ready to treat mites or leafhoppers to preserve functional leaf area

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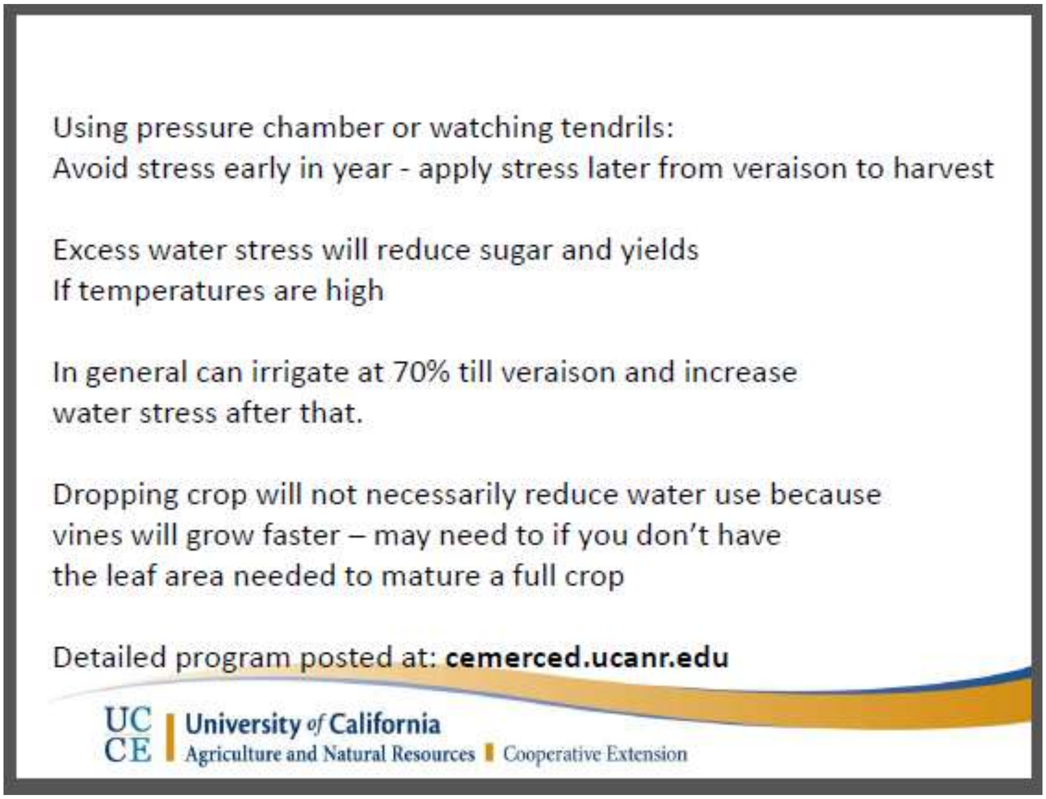
Using pressure chamber or watching tendrils:
Avoid stress early in year - apply stress later from veraison to harvest
Excess water stress will reduce sugar and yields
If temperatures are high
In general can irrigate at 70% till veraison and increase
water stress after that.
Dropping crop will not necessarily reduce water use because
vines will grow faster – may need to if you don't have
the leaf area needed to mature a full crop
Detailed program posted at: cemerced.ucanr.edu
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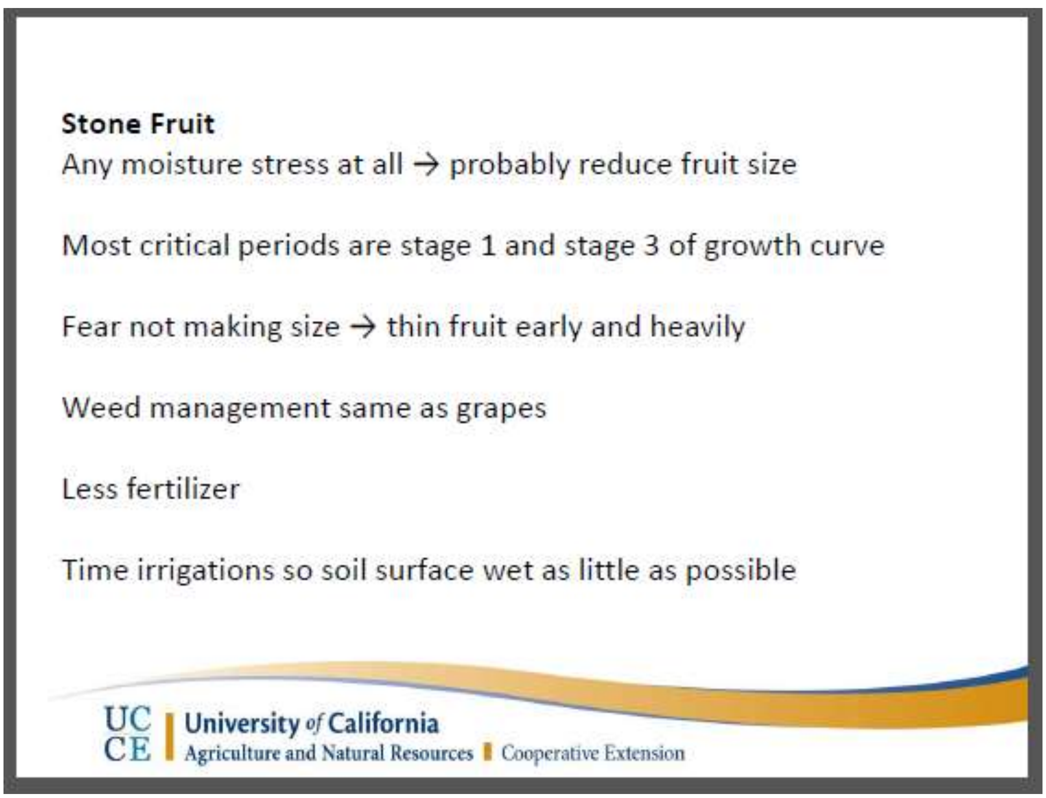
Stone Fruit
Any moisture stress at all → probably reduce fruit size
Most critical periods are stage 1 and stage 3 of growth curve
Fear not making size → thin fruit early and heavily
Weed management same as grapes
Less fertilizer
Time irrigations so soil surface wet as little as possible
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Drought Management for Almonds

Dave Doll

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Agriculture and Natural Resources | Cooperative Extension

Applying the Water

UC ANR

2 Strategies:

0-15% reduction:
RDI applied during June/Hullsplit period

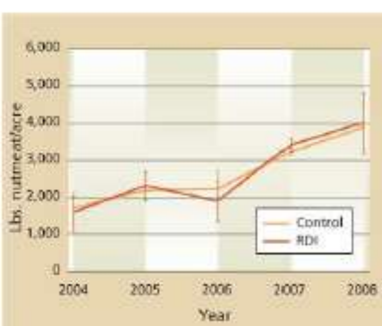
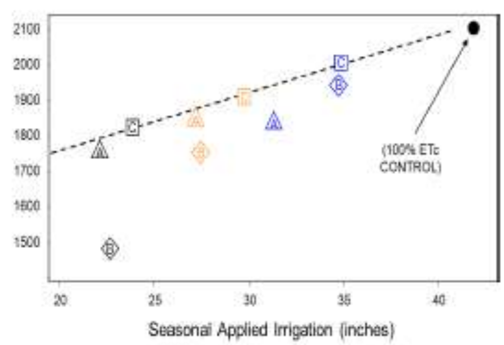


Fig. 1. Annual pattern of nutmeat yield, 2004–2008. Error bars are ± 2 SE.

16% or greater reduction:
Apply available water at the percentage of available ETc evenly through the season



(Goldhamer et al., 2006)

Severe Drought: Expectations

Growth and Yield will be Impacted:

- Reduction of kernel weights from current seasons deficit
- Reduction of growth and bud development reduces next year's crop
- Results will be compounded if deficit is continued into a second (or third year)
- Yields will take two years at full irrigation to recover.

For More Information:

- Contact UC Cooperative Extension in Merced – 209-385-7403
- www.thealmonddoctor.com
- ucmanagedrought.ucdavis.edu

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Dry Year Crop Irrigation Tables

Surface Irrigation Dry Year

Month	Precipitation	ETo (inches)	Almonds	Corn	Alfalfa	Per-Pasture	Grain/Oats/Rye	Tomatoes	Rice	Sweet Potatoes	Cotton	Silage	Misc. Deciduous
Jan	2.35	0.9	0.61	0.64	0.94	0.64	0.72	0.92	0.64	0.92	0.64	0.64	0.61
Feb	1.06	1.77	1.44	1.28	1.85	1.8	1.86	1.46	1.28	1.46	1.28	1.80	1.25
Mar	1.85	3.40	2.32	2.46	3.56	2.88	3.55	2.57	1.55	2.57	1.54	2.88	2.17
Apr	0.57	5.27	3.68	1.53	5.20	4.38	5.29	5.31	1.25	5.31	1.26	4.38	3.15
May	0.05	7.74	6.10	2.54	6.53	7.09	3.66	8.04	7.05	8.04	1.53	7.09	6.05
June	0	8.10	6.01	6.92	6.85	7.50	0.01	8.32	9.08	8.32	4.64	7.50	6.50
July	0.01	8.47	6.37	8.27	7.04	7.79	0.01	7.42	9.70	7.42	8.30	7.79	6.94
Aug	0	7.34	6.06	4.99	6.23	6.85	0	0.07	8.34	0.07	7.43	6.85	5.79
Sept	0.03	5.84	4.05	0.34	4.79	5.34	0.03	0.03	2.41	0.03	5.36	5.34	4.69
Oct	0	4.09	2.11	0	1.65	3.01	0	0	0	0	1.16	3.01	1.99
Nov	0.33	1.82	0.25	0.25	1.43	0.69	0.78	0.25	0.25	0.25	0.25	0.69	0.25
Dec	0.11	1.53	0.14	0.14	1.45	0.14	0.37	0.14	0.14	0.14	0.14	0.14	0.14
Annual	6.35	56.27	39.14	29.36	47.51	48.1	16.29	34.52	41.68	34.52	33.54	48.1	39.54

Sprinkler Irrigation Dry Year

Month	Precipitation	ETo (inches)	Almonds	Corn	Alfalfa	Per-Pasture	Grain/Oats/Rye	Tomatoes	Sweet Potatoes	Cotton	Silage	Misc. Deciduous
Jan	2.35	0.90	0.61	0.64	0.94	0.64	0.72	0.64	0.92	0.64	0.64	0.61
Feb	1.06	1.77	1.45	1.28	1.85	1.80	1.86	1.28	1.46	1.28	1.80	1.25
Mar	1.85	3.40	2.33	2.46	3.56	2.88	3.55	2.03	2.57	1.55	2.88	2.23
Apr	0.57	5.27	3.68	1.48	5.20	4.38	5.29	1.16	5.31	1.26	4.38	3.19
May	0.05	7.74	6.12	2.57	6.53	7.09	3.66	4.06	8.04	2.11	7.09	6.12
June	0	8.10	6.03	6.89	6.85	7.50	0.01	8.02	8.32	4.60	7.50	6.44
July	0.01	8.47	6.32	8.27	7.04	7.79	0.01	6.84	7.42	8.31	7.79	6.87
Aug	0	7.34	6.08	5.01	6.23	6.85	0	0.41	0.07	7.44	6.85	5.92
Sept	0.03	5.84	4.06	0.35	4.79	5.34	0.03	0.03	0.03	5.36	5.34	4.53
Oct	0	4.09	2.12	0	1.65	3.01	0	0	0	1.31	3.01	2.07
Nov	0.33	1.82	0.25	0.25	1.43	0.69	0.78	0.25	0.25	0.25	0.69	0.25
Dec	0.11	1.53	0.14	0.14	1.45	0.14	0.37	0.14	0.14	0.14	0.14	0.14
Annual	6.35	56.27	39.18	29.35	47.51	48.10	16.29	24.86	34.52	34.24	48.10	39.63

Drip/Microspray Irrigation Dry Year

Month	Precipitation	ETo (inches)	Almonds	Tomatoes	Sweet Potatoes	Cotton	Misc. Deciduous
Jan	2.35	0.9	0.61	0.64	0.92	0.64	0.61
Feb	1.06	1.77	1.40	1.28	1.46	1.28	1.25
Mar	1.85	3.40	2.31	2.03	2.50	1.54	2.09
Apr	0.57	5.27	3.85	1.13	5.06	1.26	3.16
May	0.05	7.74	6.40	3.75	7.78	1.16	6.11
June	0	8.10	6.60	8.05	8.14	4.37	6.47
July	0.01	8.47	6.89	7.17	7.17	8.46	6.71
Aug	0	7.34	5.96	0.64	0.07	7.63	5.84
Sept	0.03	5.84	4.41	0.03	0.03	5.50	4.36
Oct	0	4.09	1.93	0	0	1.50	2.07
Nov	0.33	1.82	0.25	0.25	0.25	0.25	0.25
Dec	0.11	1.53	0.14	0.14	0.14	0.14	0.14
Annual	6.35	56.27	40.76	25.1	33.52	33.72	39.06

APPENDIX D

NOTICE OF PUBLIC HEARING & PLAN PREPARATION, AFFIDAVIT OF PUBLICATION & PLAN ADOPTION RESOLUTION

NOTICE OF PUBLIC HEARING

Notice is hereby given that the Merced Irrigation District (MID) will hold a public hearing Tuesday July 5, 2016 at 10:00AM at the City of Merced Civic Center, located at 678 W. 18th Street, to discuss draft updates to MID's 2015 Agricultural Water Management Plan (AWMP).

Recent changes in California law requires agricultural water agencies in California to update their AWMPs to include, among other things, a detailed drought management plan. To meet this requirement, MID has drafted updates to its existing AWMP to include a drought water management plan, information regarding water supply and demand, various programs policies and efficient water management practices.

The MID Board of Directors will hold a hearing to receive and consider public comments on the draft updates to its AWMP. A draft revised AWMP is available for review on the MID website at www.mercedid.org.

Written comments prior to the hearing should be directed to:
Hicham Eltal
Merced Irrigation District
P.O. Box 2288
Merced, CA. 95344
Or for any questions please contact Hicham Eltal at (209) 354-2854.

APPENDIX D

AFFIDAVIT OF PUBLICATION

This space reserved for County Clerk's Filing Stamp

Declaration of
(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:

JUNE 15, 18, 22, 25, 29, 2016
JULY 2, 2016

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

Signature

JULY 2, 2016

Notice of Public Hearing

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MER-2501934 6/15, 18, 22, 25, 29, 2

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

APPENDIX D

PLAN ADOPTION RESOLUTION

MERCED IRRIGATION DISTRICT
RESOLUTION NO. 2016-17

RESOLUTION ADOPTING THE MERCED IRRIGATION DISTRICT AGRICULTURAL WATER MANAGEMENT PLAN UPDATE, AMENDING AND SUPERSEDING THE DISTRICT'S EXISTING AGRICULTURAL WATER MANAGEMENT PLAN, AND ADOPTING NOTICE OF EXEMPTION RELATING THERETO

WHEREAS, the Board of Directors of the Merced Irrigation District adopted its existing Agricultural Water Management Plan on September 3, 2013 pursuant to the Water Code Section 10900 et. seq.; and

WHEREAS, the District has prepared an update to its Agricultural Water Management Plan, pursuant to Water Code Section 10800, et. seq., Section 10900 and Section 10608.48, 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; and

WHEREAS, in addition to the components of the previous adopted plan, the current plan includes a Drought Management Plan per Governor Brown issued Executive Order B-29-15 on April 1, 2015, directing agricultural water suppliers to include a detailed drought management plan (DMP) that describes the actions and measures the supplier will take to manage water demand during drought; 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, the California Environmental Quality Act (CEQA) and the Water Code exempts certain projects from the environmental review process, including Agricultural Water Management Plans created pursuant to Water Code requirements, which are exempt from compliance with CEQA pursuant to applicable provisions of state law including Water Code §§10851 and the general exemption provided for under the CEQA Guidelines §15061; and

WHEREAS, staff has conducted a review of the Agricultural Water Management Plan and CEQA and has presented that review to the Board, including its corrective action plan for compliance with SBX 7-7 measurement requirements.

NOW, THEREFORE, BE IT HEREBY RESOLVED THAT:

1. The recitals hereto are true and correct, and are incorporated herein.
2. The Merced Irrigation District Agricultural Water Management Plan as presented and prepared in accordance with Senate Bill x7-7, attached hereto as Attachment 'A', is adopted and supersedes all previous agricultural water management plans.
3. The Board determines that the Agricultural Water Management Plan referenced herein is exempt from compliance with CEQA pursuant to applicable provisions of state law including

Water Code §§10851 and the general exemption provided for under the CEQA Guidelines §15061. The Board authorizes the General Manager or General Counsel to sign and file a Notice of Exemption if said officers deem it appropriate or desirable.

4. The General Manager or his designee is authorized to submit copies of the Agricultural Water Management Plan to agencies and entities as may be appropriate or desired.
5. The Agricultural Water Management Plan shall be posted on the Merced Irrigation District web site, and made available for public review, no later than 30 days from this date.

PASSED AND ADOPTED by the Board of Directors of Merced Irrigation District this 5th day of July, 2016, by the following vote:

Ayes:	Directors:	Gonzalves, Long, Marchini, Pimentel
Noes:	Directors:	None
Abstain:	Directors:	None
Absent:	Directors:	Koehn

David Long
President
Merced Irrigation District

Scott Koehn
Vice President/Secretary
Merced Irrigation District

APPENDIX E

MERCED GROUNDWATER BASIN
REGIONAL GROUNDWATER MANAGEMENT PLAN

The Merced Groundwater Basin –Groundwater Management Plan Update is available on the MAGPI website at: http://magpi-gw.org/index.cfm/groundwater-management-plan/ or available on hard copy at the MID Library located at the MID Main office, 744 W. 20th Street, Merced.

APPENDIX F

WATER MEASUREMENT DOCUMENTATION AND REPORTING

CCR §597.4(e) Reporting in Agricultural Water Management Plans

The California Water Code, CWC §10608.48 (b) (1) stipulates that Agricultural water suppliers shall: "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)."

This appendix includes required documentation regarding compliance with the Regulation and is organized as follows:

1. Background
   A. Existing On-Farm Irrigation Systems
   B. MID's Existing Turnout Configurations
   C. Existing Flow Rate Measurement Configurations
2. Analysis and Evaluation of Existing Flow Measuring Devices (CCR §597.4(a)(1))
   A. Inventory and Attribute Classification of Delivery Structures
   B. Protocols for Field-Testing and Evaluation of Meter-Gate Turnout Configurations
   C. Results, Step 1, Meter-Gate Evaluation
3. Water Measurement Corrective Action Plan (CAP)
4. Approved Measurement Devices and Meters

1. Background

Prior to performing an evaluation, it is important to understand and categorize the various infrastructure and operational components that impact measurement at the turnout. Major components include on farm irrigation systems, turnout configurations and flow rate measurement configurations, each discussed in more detail below.

A. Existing On-Farm Irrigation Systems

Existing on-farm irrigation systems can be generally classified into three major categories:

1. Open Flow systems (gravity)
2. Pressurized Systems
3. Integrated Systems

Open flow systems are typically associated with flood or furrow irrigation methods, while pressurized systems are typically associated with sprinkler systems, mircomist systems, drip, impact sprinklers, etc. Integrated systems are designed to serve one field, but have private piping or ditch connections that can convey MID water supplies to other fields.

B. MID's Existing Turnout Configurations

Generally speaking, there are five primary types of turnouts at MID:

1. Upright structures
2. Canal gates on headwalls
3. Slant structures
4. Concrete boxes on pipelines
5. Other turnout configurations including:
    a. Concrete Standpipes on pipelines
    b. Booster Pump or Groundwater Well Systems: These systems typically discharge to a pipeline that then serves one or more growers by connecting to the growers' pipelines, standpipe or boxes.
    c. Pressure Boxes: Concrete boxes with poured-in-place top (i.e., not open top concrete box).
    d. Alfalfa valves on an MID pipeline
    e. Inline valves
    f. Other non-standard configurations

Flow through each primary type of turnout is typically controlled with a canal gate (such as a standard Fresno Valve C101 gate), while delivery flows through booster pump and groundwater well systems are dependent on the specific installation configuration and include canal gates, gate valves, butterfly valves and other methods.

C. Existing Flow Rate Measurement Configurations

There are two primary measurement configurations within MID, metered turnouts and meter-gate turnouts.

Metered Turnouts

Flows to fields measured with a meter, such as the McCrometer Propeller Meter or other MID approved, factory calibrated meter, can be associated with any of the aforementioned turnout configurations. MID staff regularly read existing meters, typically once per week, to determine the volume of water for billing purposes. In practice, the DSO enters the current meter read into the operations database, which subtracts the previous meter read and calculates AF for billing purposes. Metered installations are typically serving Pressurized Irrigation Systems, although a few Open Flow Systems have installed meters.

Meter-Gate Turnouts

Flow rates through meter-gate structures are measured with a canal gate. Canal gates, such as a standard Fresno Valve C101 gate, installed vertically and including a downstream measuring vent, provide instantaneous flow readings based on a manufacturer specific rating table and the differential head across the gate and the gate opening. These configurations typically serve Open Flow Systems, although some Pressurized Irrigation Systems are measured using this method. Measuring with a canal gate consists of taking measurements of the head differential across the gate and the gate opening. These readings are compared to a rating table from the gate manufacturer, which correlates to an instantaneous flow rate. The instantaneous flows are then multiplied by the duration of the irrigation event to determine the volumetric total which is used for billing. The DSO enters the instantaneous flow rate, delivery start time and end time, as well as the time and value of any flow changes, into the operations database, which performs the acre-foot calculation for billing purposes.

This method is used for upright structures, canal gates on headwalls, and deliveries from concrete boxes and standpipes. Flow rates through slant structure meter-gates are estimated from a combination of available tools, such as measuring flow in grower ditches, crop-soil science relationships and estimated ETc values, measuring the flow upstream and downstream of the turnout, estimating flows based on the specifications and quantity of sprinkler heads or other distribution devices, etc. Flow rate measurement techniques for turnouts classified as "Other" are similar to those used for other meter-gate measurement structures, depending on the turnout details and the grower's on-farm irrigation system. Meter-gate measurement configurations are typically measured once during an irrigation and as needed depending on changing conditions.

2. Analysis and Evaluation of Existing Flow Measuring Devices (CCR §597.4(a)(1))

An analysis and evaluation of MID's existing metered turnout configurations was conducted and reported under the 2013 AWMP. A summary of that effort is presented herein – please refer to MID's 2013 AWMP (http://www.mercedid.com/index.cfm/water/ag-water-management-plan/) for protocols and other detailed information regarding the evaluation. This section includes:

A. Inventory and Attribute Classification of Delivery Structures
B. Protocols for Field-Testing and Evaluation of Meter-Gate Turnout Configurations
C. Results, Step 1, Meter-Gate Evaluation of Measurement Certification

Detailed protocols and results of the analysis and evaluation of MID's meter-gate turnout configurations are reported herein.

A. Inventory and Attribute Classification of Delivery Structures

2011 was used as representative of the District's average delivery gate activities. Since 2011, the region has been in a drought and later years may not be representative of full turnout activity. An inventory and attribute classification of all turnouts active during the 2011 irrigation season (i.e., operated and served water in 2011) was performed. Results are presented in Table F-1.

Table F-1
Turnout Inventory and Classification

Turnout Type	Meter-Gate Turnouts		Metered Turnouts	
	Quantity	Acreage Served	Quantity	Acreage Served
Upright Structure	689	36,554	196	12,237
Slant Structure	368	13,549	127	5,656
Concrete Box	213	9,637	87	4,527
Other	55	3,163	111	9,033
Concrete Headwall	46	2,212	14	1,396
Stand Pipe	45	1,640	17	800
Total	**1,416**	**66,755**	**552**	**33,649**

B. Protocols for Field Testing and Evaluation of Meter-Gate Turnout Configurations

1. Selection of Turnouts for Evaluation

The Regulation requires:

a. A random sample of 10-percent of each turnout type must be evaluated for compliance.

b. Twenty-five percent of the evaluated turnouts shall meet the accuracy criteria of ±12 percent for that "turnout type" to be considered compliant with the Regulation.

There are a wide range of field sizes within MID, thus, a random sample set based on a percentage of each turnout type may only represent a small portion of total water delivered to the District. To correct this delivery volume bias, a sampling procedure based on turnout type and acreage, rather than just the turnout type was adopted.

Table F-2 shows the total quantity and acreage served for each turnout configuration and the quantity and acreage served for each evaluated turnout configuration. As shown, the turnouts selected for evaluation provide service to at least 10 percent of the acreage served by each turnout configuration.

Table F-2
Turnouts Selected for Evaluation

Turnout Type	Total Active Turnouts		Turnouts Selected for Evaluation		
	Quantity	Acreage Served	Quantity	Acreage Served	% of Total Acreage Served
Upright Structure	689	36,554	63	5,611	15%
Slant Structure	368	13,549	NA	NA	NA
Concrete Box	213	9,637	20	2,158	22%
Other	55	3,163	NA	NA	NA
Concrete Headwall	46	2,212	4	220	10%
Stand Pipe	45	1,640	6	286	17%
Total	**1,416**	**66,755**	**NA**	**NA**	**NA**

Certain turnout configurations were not selected for evaluation, as it was determined that they do not provide accurate measurement sufficient to meet the Regulation. These turnout configurations are included in the water measurement CAP and included turnout configurations "Slant Structure" and "Other".

2. Protocols for Field Testing and Evaluation

To verify whether a meter-gate turnout configuration meets the requirement of the Regulation, an independent flow test would be required for each of the 93 turnouts selected for evaluation, similar to those performed on metered turnouts. Due to the logistical difficulties with that approach and District staff's experience with these turnouts, the evaluation was designed to be performed in two steps:

a. Determine which turnouts don't comply by nature of their physical configuration
    i. For example, the manufacturer of Calco gates, MID's typical canal gate, have developed a rating table for Calco gates. Based on MID's past experience measuring and calibrating these gates on District turnouts, it has been determined that for the rating to be accurate, certain physical installation parameters must be valid. Some of the parameters include limits on the head differential between the upstream and downstream sides of the gate, the location of the downstream measuring well and the actual structure width on either side of the gate.
    ii. If a sufficient number of turnouts failed to meet the physical configuration requirements, then final flow test verification would not be necessary, as the turnout configuration would be considered non-compliant with the Regulation.

b. If a sufficient number of turnouts meet the physical configuration requirements, then perform a final verification flow test of each of the selected turnouts. These results would then be used to determine if the turnout configuration meets the Regulation.

D. Results, Step 1, Meter-Gate Evaluation

For each of the meter-gate turnout configurations evaluated, more than twenty-five percent of each configuration failed to meet the Step 1 criteria. Based on these results, each meter-gate turnout configuration is considered not compliant with the Regulation and Step 2 of the evaluation is not required. Each meter-gate turnout configuration is considered not compliant with the Regulation and is included in the water measurement CAP. Table F3 presents the results of this evaluation.

Table F-3
Results, Step 1, Meter-Gate Evaluation

Turnout Configuration	No. Evaluated	No. Pass	No. Fail	% Fail (Criteria < 25%)
Concrete Box	20	1	19	95%
Concrete Standpipe	6	0	6	100%
Concrete Headwall	4	0	4	100%
Upright Structure	63	2	61	97%

3. Water Measurement Corrective Action Plan, CAP

This water measurement CAP is intended to ensure that the District:

- Achieves compliance with the flow measurement component of SBX 7-7 (the Regulation)
- Provide Reasonable Policy Guiding District's Flow Rate Measurement Standards

Based on the required turnout evaluations, metered turnout configurations were deemed compliant with Regulation while all meter-gate turnout configurations were deemed non-compliant with the Regulation and corrective actions are included in this CAP to bring the non-compliant turnouts into compliance. Non-commercial water accounts are not subject to this CAP as they are exempt from the Regulation.

A. Certification

Certification of new or replacement measurement devices shall be as follows:

1. Laboratory Certified: ± 5 Percent by Volume
2. Non-Laboratory (Field) Certification: ± 10 Percent by Volume

B. Measurement Device Location

Standards for measurement device locations used to measure MID water supplies shall be as described herein. Where the standard location is infeasible, as determined by MID, the District will determine alternate location(s)

1. Pressure Systems: Incorporated into on-farm system (unless requested otherwise by grower)
2. Open flow systems:
    a. Measurement shall be at the turnout or immediately downstream
    b. If a field uses more than one turnout, measurement shall be at each turnout
    c. Alfalfa valves on an MID pipeline: Measure before and after valves if feasible
3. Boosters pumping from MID facility: Downstream piping of booster pump
4. Deliveries to multiple growers via private ditches/pipelines
    a. In-District Parcels: Measure at MID's last point of control
    b. In-District/Out-of-District Parcels: Measurement location(s) sufficient to individually measure all MID water supplies to both In-District and Out-of-District parcels connected to same on-farm system

C. Measurement Configuration Requirements

When implementing measurement improvements, the following measurement configuration standards must be met. When the standard configuration is infeasible, as determined by MID, the District will determine alternate configurations:

1. Measure MID water supplies separately from private groundwater supplies without need for operational coordination
2. Can measure all MID water supplies by ensuring that there are no built in by-passes around meters (alternatively, bypass shall be metered)
3. Can separately measure MID water supplies to both In-District and Out-of-District parcels connected to same on-farm system
4. Meter installations to allow for independent flow testing, where feasible

D. Implementation

Measurement improvements shall be implemented at all meter-gate turnouts.

Metered turnout configurations have been determined to meet the Regulation and no corrective actions are required. However, for improved water management purposes and to ensure that MID continues to be able to achieve accurate measurement to existing metered fields, the District will initiate an ongoing existing metered turnout installation evaluation and improvement program.

Prioritization

Measurement improvements and the installation evaluation and improvement program shall be implemented in accordance with the following prioritization:

1. Existing meter-gate turnouts
   a. Initiate measurement improvements when grower modifies its on-farm system or makes modifications to the District's turnout(s)
   b. Initiate measurement improvements to all meter-gate turnouts, regardless of whether any modifications are being made to an on-farm system or District turnout in accordance with the schedule shown in Table F4, Meter-Gate Measurement Improvement Prioritization Schedule

Table F-4
Meter-Gate Measurement Improvement Prioritization Schedule

Parcel Acreage Grouping	Schedule	Parcel Size Range	Cumulative Acreage Served by Measurement Improvements	
			Total	Percent of Total
70 to 500+	Years 1-5	>500	574	1%
		400-500	3,235	5%
		300-400	6,885	10%
		200-300	13,804	21%
		100-200	27,736	42%
		90-100	30,580	46%
		80-90	32,708	49%
		70-80	37,204	56%
40 to 70	Years 6-10	60-70	40,037	60%
		50-60	44,109	66%
		40-50	47,521	71%
20 to 40	Years 11 - 15	30-40	54,980	82%
		20-30	58,879	88%
0 to 20	Years 16 - 20	10-20	65,416	98%
		5-10	66,666	100%
		<5	66,755	100%

2. Existing metered turnouts
   a. Initiate installation evaluation and improvement program activities when grower modifies its on-farm system or makes modifications to the District's turnout(s)

b. Initiate ongoing installation evaluation and improvement program to all metered turnouts, regardless of whether any modifications are being made to an on-farm system or District turnout.

Implementation Process

Once measurement improvements are triggered by the applicable prioritization schedule, the following activities will occur, unless other implementation processes are determined to be more effective, as determined by MID:

1. Meter-gate turnouts
   a. MID will evaluate the turnout, including the grower's on-farm system, turnout configuration and existing measurement configuration and design appropriate measurement improvements.
   b. Grower will be required to construct said improvements within 12 months of being advised in writing of the need to construct improvements and being provided with the measurement improvement design.
   c. When measurement improvements serve more than one field (i.e. where measurement is at MID's last point of control delivering to a private ditch/pipeline system
   d. MID will notify each grower served by said turnout that measurement improvements will be implemented.
2. Metered turnouts
   a. Evaluate current metered turnout installations for compliance with the CAP

      If the evaluation determines that the existing measurement configuration does not meet the requirements of this CAP

      i. MID to determine required measurement improvements, including system configuration changes and/or additional meter installation(s).
      ii. MID will coordinate with grower regarding necessary on-farm system configuration changes.
      iii. Grower will be required to construct said improvements within 12 months of being advised in writing of the need to construct improvements and being provided with the measurement improvement design.
   b. For planned on-farm or turnout modifications initiated by grower, MID will review grower's planned modifications and provide measurement requirements including the number, location and type of meters, as well as any on-farm modifications, necessary to comply with the CAP.
   c. Flow Meter Maintenance Program
      i. MID to perform flow tests on existing meters to certify their accuracy meets requirements of this CAP.
      ii. If flow test indicates meter does not meet MID accuracy requirements of this CAP, MID will perform maintenance and calibrate or replace said meter (in coordination with grower).

4. Approved Measurement Devices and Meters

MID will design required measurement improvements, including determining the location(s) and type of meter(s) or measurement device(s) that are required. Due to the wide variety of turnout and on-farm irrigation system configurations, more than one type of meter and measurement device will be required to implement measurement to every water account.

The type of meter selected for a specific turnout or field will depend on whether the meter is measuring un-filtered surface water or is located downstream of a filter station. Each meter may have certain operational parameters that must be considered to determine whether it is applicable in a specific installation, such as minimum and maximum flow rates or velocities. Where measurement at the turnout is required, the selection of a measurement device will be dependent on the physical configuration of the turnout.

Table F7, Approved Measurement Devices and Meters, contains a list of currently approved meters and measurement device, as well as estimated costs of the meters, for various applications. Note that the estimated meter costs do not include installation costs or costs associated with downstream piping or structure modifications (which will be necessary at numerous turnouts and some on-farm systems). This is not a final list. There are limited devices or meters with a long service history in the agricultural industry. MID is continuing to perform research and pilot test devices and meters and is continuing to work with vendors, Cal Poly ITRC and other irrigation districts to develop cost effective, viable options for turnout and on-farm measurement devices and meters.

Table F7
Approved Measurement Devices and Meters
(will continuously be evaluated and updated)

Device/Meter	Available Sizes	Approved Locations		
		On-Farm System		Turnout
		Unfiltered Water	Filtered Water	
Mag Meter, Full Bodied Flanged	4”–48”	Yes	Yes	Yes
	3”-12”	Yes	Yes	Yes
Mag Meter, Saddle Insertion	4”-12”	TBD	Yes	TBD
Mag Meter, Insertion	2”-96”	TBD	Yes	TBD
Propeller Meter, Open	10”-72”	No	Yes	No
Propeller Meter, Saddle, Trash Shredding	4”-16”	TBD	Yes	TBD
Propeller Meter, Large Diameter Saddle	18”-36”	No	Yes	No
Turnout Meter Gate	24”-48”	No	No	Yes

APPENDIX G
WATER MANAGEMENT IMPLEMENTATION PLAN (WMIP)

MERCED IRRIGATION DISTRICT
WATER & POWER

APPLICATION AGREEMENT

☐ **Water Reallocation** ☐ **Private Groundwater Wheeling** ☐ **Private Groundwater Exchange**

Tenant may complete for Owner if an existing Owner/Tenant Agreement is on file at MID.

CONTRIBUTING PARCEL

Owner(s): ______________________

If owner is a business, please include name of authorized representative.

Water Account Number: ____________ APN(s): ____________ Gross Irrigated Acres: ____________

Lessee: ______________________

Address: ____________ Phone Number: ____________

City, State, Zip ____________ Alternate Number: ____________

RECEIVING PARCEL

Owner(s): ______________________

If owner is a business, please include name of authorized representative.

Water Account Number: ____________ APN(s): ____________ Gross Irrigated Acres: ____________

Lessee: ______________________

Address: ____________ Phone Number: ____________

City, State, Zip ____________ Alternate Number: ____________

Reallocation

Reallocate ________ X ________ = ________ (calculated acre-feet)
Gross Irrigated Acres — Acre-Feet per acre

Existing Allocation:
Contributing Parcel ________ AF ________ AF/AC Receiving Parcel ________ AF ________ AF/AC

Used MID water within the last three years? Circle one: Yes/No

Resulting Allocation:
Contributing Parcel ________ AF ________ AF/AC Receiving Parcel ________ AF ________ AF/AC

March 5, 2013 Page **1** of **6**

Private Groundwater Wheeling	***Contributing Parcel*** Private Pump Estimated Yield: ________ Properly Installed Flow Meter (circle one): Yes/No • Water wheeling fee of $______/_____ • A loss of 5% per mile will be calculated from the volume being delivered to receiving parcel • Costs for exchange will be the responsibility of the Contributing Parcel • Requires a flow meter (see General Provisions on the following page) **Irrigation Operations:** ____________________ Approved ____________________ Denied Net Volume at Receiving Parcel = volume @ pump – (0.05 x __________ x volume @ pump) number of miles For multiple separated events of Groundwater Wheeling, grower shall obtain signed approval from Irrigation Operations.
Private Groundwater Exchange	***Contributing Parcel*** Tender Area: __________ Canal/Lateral: ______________ ***Receiving Parcel*** Tender Area: __________ Canal/Lateral: ______________ Private Pump Estimated Yield: ________ Properly Installed Flow Meter (circle one): Yes/No • Water wheeling fee of $______/_____ • A loss of 40% lump sum will be calculated from the volume being delivered to receiving parcel • Costs for exchange will be the responsibility of the Contributing Parcel • Requires a flow meter (see General Provisions on following page) Net Volume at Receiving Parcel = volume @ pump – (0.4 x volume @ pump) Approximate date of discharge: ______________________ Date receiving water: ______________________ (Must be within 30 days)
For Office Use Only	☐ Water Reallocation ☐ Groundwater Wheeling ☐ Groundwater Exchange **DEPUTY GENERAL MANAGER:** ____________________ Approved/Denied

2013 Irrigation Season
Water Management Implementation Plan

This Water Management Implementation Plan (Plan) provides a framework for monitoring and accounting for water deliveries that provides MID growers flexibility regarding the use of both MID and non-MID water supplies, while helping to ensure that the following water management objectives are achieved:

1. Maintain equitable service to all MID growers
2. Meet the District's reservoir carryover storage goal at the end of the season
3. Control and properly account for all water conveyed through MID facilities, including both surface and groundwater supplies

To achieve these objectives, guidelines have been developed that will govern the following practices:

- General guidelines
- Account Setup
- Allocation Management
- Groundwater Wheeling and Groundwater Exchange Management

General Guidelines

1. The Manger of Water Operations or designee shall make all necessary MID determinations regarding compliance with these guidelines.
2. Requests to implement any described transaction may be denied on a case-by-case basis if such transaction is determined to be detrimental to the District achieving its water management objectives for the season.
3. Water orders and deliveries shall be initiated per the established MID Water Distribution Rules Governing Distribution of Water, except where provisions in this policy may differ.
4. Tail water may not be discharged into the MID water conveyance system. It is not re-allocatable, wheelable, or exchangeable.

Account Setup:

1. Water Accounts consist of portions of one or more parcels that are farmed as a unit.
2. Customer accounts (or Customer ID's or Billable Accounts) consist of one or more water accounts owned by the same entity.
3. Growers may establish a Master ID, which would consist of two or more Customer accounts. Prior to establishing a Master ID, an authorized representative from each Customer account must sign the required Master ID Setup Form.

Allocation Management

1. All water allocations are at the parcel(s) level, which are managed by a Water Account, and are based on gross irrigated acres (parcel acreage) contained within the Water Account.
2. Annually, the MID Board of Directors (the Board) will determine the surface water allocation for MID growers (Growers), including both Class I and Class II water users, on an AF/AC basis.
3. The Board has authorized a Supplemental Water Supply Pool Program (Program) to Class I water users through groundwater pumping.
    a. For 2013, Supplemental Water Supply Pool Program water will be charged out at $73.25/AF.
    b. Supplemental Program water cannot be reallocated, wheeled or exchanged.
    c. This is a voluntary program.
    d. Garden Heads (parcels less than 5 acres) are not eligible for this Program.
    e. See the document "Supplemental Water Supply Pool Program (February 19, 2013)" for more information regarding the Program.
4. A Growers' total water allocation for the season will consist of the surface water allocation and any Program water subscribed to.
    a. Once a Grower has subscribed to supplemental Program water, this "allocation" will be added to their surface water allocation for the 2013 irrigation season.
    b. From this point forward, each Water Account will have a total allocation consisting of both the surface water allocation **and** the supplemental Program water subscribed to. For example, if the available surface water allocation is 2.4 AF/AC and 0.6 AF/AC of supplemental Program water is subscribed to, the total allocation for that Water Account for the season will be 3.0 AF/AC.
5. Total allocations will be managed at the Customer ID or Master ID level, where possible.
6. Growers may reallocate all or a portion of their surface water allocation to another Grower.
    a. Growers that want to reallocate all or a portion of their surface water allocation to another MID Grower must complete the appropriate form and turn it into Customer Service.
    b. Water reallocations amongst and between Growers will be at the Water Account level. In other words, both parties to the transaction must identify the individual water account(s) associated with their Customer ID that water will be reallocated from and to.
    c. There are no additional charges for in-District water reallocations.
    d. No water reallocations shall be allowed from garden heads.
    e. No surface water allocation can be reallocated to lands outside of MID, such as SOI grounds.
    f. Water cannot be reallocated from a Water Account that has not received MID surface water or groundwater sufficient to grow a crop within the three previous irrigation seasons, as determined by MID.

Private Groundwater Wheeling and Private Groundwater Exchange Management

1. Definitions:

    a. Private Groundwater Exchange: The exchange of MID canal water at a receiving parcel with discharged private well water into District facilities from a contributing parcel. (e.g., downstream contributing parcel exchanging water with an upstream receiving parcel, or a West Division receiving parcel exchanging with an East Division contributing parcel).

    b. Private Groundwater Wheeling: The act of conveying private well groundwater discharged from an upstream contributing parcel through an identified portion of the MID conveyance system to a downstream receiving parcel.

2. General Guidelines:

    a. Growers must complete the Private Groundwater Wheeling/Private Groundwater Exchange (wheeling/exchange) Request Form to be considered for wheeling/exchange. After review and approval of the request by MID, wheeling/exchange shall be allowed between in-District parcels. Approval of the request is subject to the guidelines discussed below.

    b. The District retains complete control over use of its distribution system and facilities. Restrictions limiting the wheeling/exchange of water will be imposed at the District's sole discretion when it deems necessary in order to meet its water management objectives for the season.

    c. All private wells discharging into MID conveyance facilities must be equipped with a properly installed and calibrated flow meter prior to the date of groundwater wheeling or groundwater exchange:

        i. There are no exceptions to this requirement.

        ii. The meter must be installed in accordance with the manufacturer's recommendations (instantaneous flow rate and totalizer required).

        iii. Calibration statements are required and must have been obtained by the use of an outside contractor acceptable to MID. Statements must be current (within the last 24 months preceding the wheeling activity).

        iv. If necessary, MID will perform or have an outside contractor perform a flow test to properly calibrate a meter. The wheeling applicant will be billed for such tests.

        v. If it is determined by MID that the flow meter is installed in such a way as to affect the accuracy of the meter, wheeling will not be allowed unless and until the installation configuration is modified and a meter is properly installed and calibrated.

3. All receiving parcel delivery locations shall be equipped with a water measuring device compliant with SBX7-7, as determined by MID.

4. The applicant must make prior arrangements with the appropriate Distribution System Operator (DSO) before any water is wheeled/exchanged in the District's distribution system.

5. Any temporary modifications to the District canal system or facilities, for wheeling/exchange purposes, will be paid for by the applicant and will be subject to complete control and approval

by the District. Such modifications will be installed and/or removed by a District approved licensed contractor.

6. Private well discharges to MID facilities may only be started or stopped with specific authorization from MID Irrigation Operations. An authorization shall be approved in writing, or any other form acceptable to the MID. Water discharged to MID facilities without such authorization shall not be recognized or credited.
7. All private well pump/motor assemblies shall be safely accessible to District employees.
8. MID shall have the right to test the water quality for any private well. MID retains the right to terminate groundwater wheeling or exchange operations if the private well discharge quality is deemed by MID, to be detrimental to MID operations, canal water quality or operational discharges. Any testing costs shall be solely borne by the applicant.

Private Groundwater Wheeling Management

1. A 5% per mile loss shall be applied for the distance between the private well discharge location and the intake at the receiving parcel location up to a maximum of 40%.
2. A groundwater wheeling fee shall be applied to wheeled water, in accordance with the MID's current fee schedule.

Private Groundwater Exchange Management

1. All water exchanges shall be subject to a 40% loss of the volume at the private well location regardless of its geographic location with respect to the receiving parcel adjusted at the discretion of MID.
2. The receiving parcel shall be required to use the exchanged volume within 30 days after the private pump discharges to MID facilities. After one month, MID does not warrant delivery and the exchangers shall forfeit their contributed water with no compensation.
3. Application for water exchange forms will not be accepted within the last two weeks of the irrigation season.

2014 Irrigation Season
Water Management Implementation Plan

This Water Management Implementation Plan (Plan) provides a framework for monitoring and accounting for water deliveries that provides MID growers flexibility regarding the use of both MID and non-MID water supplies, while helping to ensure that the following water management objectives are achieved:

1. Maintain equitable service to all MID growers
2. Meet the District's reservoir carryover storage goal at the end of the season
3. Control and properly account for all water conveyed through MID facilities, including both surface and groundwater supplies

To achieve these objectives, guidelines have been developed that will govern the following practices:

- General Guidelines
- Account Setup
- Allocation Management
- Groundwater Wheeling and Groundwater Exchange Management

General Guidelines

1. The Manager of Water Operations or designee shall make all necessary MID determinations regarding compliance with these guidelines.
2. Requests to implement any described transaction may be denied on a case-by-case basis if such transaction is determined to be detrimental to the District achieving its water management objectives for the season.
3. Water orders and deliveries shall be initiated per the established MID Water Distribution Rules Governing Distribution of Water, except where provisions in this policy may differ.
4. Tail water may not be discharged into the MID water conveyance system. It is not re-allocatable, wheelable, or exchangeable.

Account Setup:

1. Water Accounts consist of portions of one or more parcels that are farmed as a unit.
2. Customer Accounts (Customer ID's or Billable Accounts) consist of one or more Water Accounts owned or leased by the same entity.
3. Growers may establish a Master ID, which would consist of two or more Customer Accounts. Prior to establishing a Master ID, an authorized representative from each Customer Account must sign the required Master ID Setup Form.

Allocation Management

1. All water allocations are at the parcel(s) level, which are managed by a Water Account, and are based on gross acres (parcel acreage) contained within the Water Account.
2. Annually, the MID Board of Directors (the Board) will determine the surface water allocation for MID growers (Growers), including both Class I and Class II water users, on an AF/AC basis.
3. The Board has authorized a Supplemental Water Supply Pool Program (Program) to Class I water users through groundwater pumping.
    a. For 2014, Program water will be charged out at $110.00/AF.
    b. Customers cannot subscribe to Program water if any Water Account contained in their Customer ID or Master ID has re-allocated surface water to another grower.
    c. Program water cannot be reallocated.
    d. This is a voluntary program.
    e. See the document "Supplemental Water Supply Pool Program" dated February 11, 2014 for more information regarding the Program. This document is located on the MID website at http://www.mercedid.org/index.cfm/water/water-rates/, and will be mailed to the growers.
4. A Growers' total water allocation for the season will consist of the surface water allocation and any Program water allocated.
    a. Once a Grower has been allocated Program water, this "allocation" will be added to their surface water allocation for the 2014 irrigation season.
    b. From this point forward, each Water Account will have a total allocation consisting of both the surface water allocation **and** the Program water allocation. For example, if the available surface water allocation is 0.5 AF/AC and 0.5 AF/AC of Program water is allocated, the total allocation for that Water Account for the season will be 1.0 AF/AC.
5. Total allocations will be managed at the Customer ID or Master ID level.
6. Growers may reallocate all or a portion of their surface water allocation to another Grower (unless allocated Program water).
    a. Growers that want to reallocate all or a portion of their surface water allocation to another MID Grower must complete the appropriate form and turn it into Customer Service.
    b. Water reallocations amongst and between Growers will be at the Water Account level. In other words, both parties to the transaction must identify the individual water account(s) associated with their Customer ID that water will be reallocated from and to.
    c. There are no additional District charges for water reallocations.
    d. No surface water allocation can be reallocated to lands outside of MID, such as SOI grounds.
    e. Water cannot be reallocated from a Water Account that has not received MID surface water or groundwater sufficient to grow a crop within the three previous irrigation seasons, as determined by MID.

f. Water cannot be reallocated if any Water Account contained in a Customer ID or Master ID has subscribed to Program water.

Private Groundwater Wheeling and Private Groundwater Exchange Management

1. Definitions:
    a. Private Groundwater Exchange: The exchange of MID canal water at a receiving parcel with discharged private well water into District facilities from a contributing parcel. (e.g., downstream contributing parcel exchanging water with an upstream receiving parcel, or a West Division receiving parcel exchanging with an East Division contributing parcel).
    b. Private Groundwater Wheeling: The act of conveying private well groundwater discharged from an upstream contributing parcel through an identified portion of the MID conveyance system to a downstream receiving parcel.
2. General Guidelines:
    a. Growers must complete the Groundwater Wheeling/Groundwater Exchange (wheeling/exchange) Request Form to be considered for wheeling/exchange. After review and approval of the request by MID, wheeling/exchange shall be allowed between in-District parcels. Approval of the request is subject to the guidelines discussed below.
    b. The District retains complete control over use of its distribution system and facilities. Restrictions limiting the wheeling/exchange of water will be imposed at the District's sole discretion when it deems necessary in order to meet its water management objectives for the season.
    c. All private wells discharging into MID conveyance facilities must be equipped with a properly installed and calibrated flow meter prior to the date of groundwater wheeling or groundwater exchange:
        i. There are no exceptions to this requirement.
        ii. The meter must be installed in accordance with the manufacturer's recommendations (instantaneous flow rate and totalizer required).
        iii. Calibration statements are required and must have been obtained by the use of an outside contractor acceptable to MID. Statements must be current (within the last 24 months preceding the wheeling activity).
        iv. If necessary, MID will perform or have an outside contractor perform a flow test to properly calibrate a meter. The wheeling applicant will be billed for such tests.
        v. If it is determined by MID that the flow meter is installed in such a way as to affect the accuracy of the meter, wheeling will not be allowed unless and until the installation configuration is modified and a meter is properly installed and calibrated.
3. All receiving parcel delivery locations shall be equipped with a water measuring device compliant with SBX7-7, as determined by MID.
4. The applicant must make prior arrangements with the appropriate Distribution System Operator (DSO) before any water is wheeled/exchanged in the District's distribution system.

5. Any temporary modifications to the District canal system or facilities, for wheeling/exchange purposes, will be paid for by the applicant and will be subject to complete control and approval by the District. Such modifications will be installed and/or removed by a District approved licensed contractor.
6. Private well discharges to MID facilities may only be started or stopped with specific authorization from MID Irrigation Operations. An authorization shall be approved in writing, or any other form acceptable to the MID. Water discharged to MID facilities without such authorization shall not be recognized or credited.
7. All private well pump/motor assemblies shall be safely accessible to District employees.
8. MID shall have the right to test the water quality for any private well. MID retains the right to terminate groundwater wheeling or exchange operations if the private well discharge quality is deemed by MID, to be detrimental to MID operations, canal water quality or operational discharges. Any testing costs shall be solely borne by the applicant.

Private Groundwater Wheeling Management

1. A 5% per mile loss shall be applied for the distance between the private well discharge location and the intake at the receiving parcel location up to a maximum of 40%.
2. A groundwater wheeling fee shall be applied to wheeled water, in accordance with the MID's current fee schedule.

Private Groundwater Exchange Management

1. All water exchanges shall be subject to a 40% loss of the volume at the private well location regardless of its geographic location with respect to the receiving parcel adjusted at the discretion of MID.
2. The receiving parcel shall be required to use the exchanged volume within 30 days after the private pump discharges to MID facilities. After one month, MID does not warrant delivery and the exchangers shall forfeit their contributed water with no compensation.
3. Application for water exchange forms will not be accepted within the last two weeks of the irrigation season.

MERCED IRRIGATION DISTRICT
WATER & POWER

2015 Water Management Implementation Plan

April 8, 2015

The Merced Irrigation District's annual Water Management Implementation Plan (Plan) provides a framework for monitoring and accounting for water deliveries, which provides MID growers flexibility regarding the use of both MID and non-MID water supplies while helping to ensure that the following water management objectives are achieved:

- Maintain Equitable Service to All Eligible Parcels under adopted Implementation Criteria; and,
- Control and Properly Account for All Water Conveyed through MID Facilities

To achieve these objectives, guidelines have been developed that will govern the following practices:

- General Guidelines
- Account Setup
- 2015 Supplemental Water Supply Pool Program
- Private Groundwater Wheeling Management

General Guidelines

1. MID's Manager of Water Operations or his designee shall make all necessary determinations regarding compliance with these guidelines.
2. Requests to implement any described transaction will be considered on a case-by-case basis consistent with MID's water management objectives for the season.
3. Water orders and deliveries shall be initiated per the established MID Water Distribution Rules Governing Distribution of Water, except where provisions in this policy may differ.
4. Tail water may not be discharged into the MID water conveyance system.

Account Setup:

1. Water Accounts consist of portions of one or more parcels that are farmed as a unit.
2. Customer Accounts (Customer ID's or Billable Accounts) consist of one or more Water Accounts owned or leased by the same entity.

Limited 2015 Supplemental Water Supply Pool Program

1. The Board has authorized a limited Supplemental Water Supply Pool Program (Program) for Class I water users through conjunctive groundwater pumping, effective April 1, 2015.
   a. This is a voluntary program.
   b. Availability based on location of parcel and availability of mid well service.

2. Process for Growers to Subscribe to Program Water
    a. If you are interested in subscribing to the Program, please complete the "2015 Supplemental Water Supply Pool Program Application," attached.
    b. Prepayment is required for participation in the Program. The amount of the prepayment is $50/Acre.
    c. The prepayment will be applied as a credit to your account. For example, if your water account acreage is 100 acres and you apply for Water Account AT123, consisting of 100 acres, then the prepayment required at the time you submit your request form would be 100 x $50 = $5,000.

Private Groundwater Wheeling

1. Private Groundwater Wheeling can be generally described as the conveyance of private well groundwater discharged from an upstream contributing parcel through an identified portion of the MID conveyance system to a downstream receiving parcel.
2. No Daily Wheeling Fee.
3. Temporary Modifications to MID Facilities for Wheeling Purposes.
    a. Allowed with Approval of MID Engineering Department.
    b. Temporary Pump Permit Required (fee waived).
    c. All Infrastructure Costs Borne by Applicant.
4. General Guidelines:
    a. Growers must complete the Groundwater Wheeling Request Form to be considered for wheeling. Approval of the request is subject to the guidelines discussed below.
    b. It is imperative MID maintain control over use of its water distribution system and facilities. Conditions on wheeling of private groundwater will be required at MID's discretion when it is deemed necessary to meet its water management objectives for the season.
    c. All private wells discharging into MID conveyance facilities must be equipped with a properly installed and calibrated flow meter prior to the date of groundwater wheeling.
        i. Exceptions to this requirement require approval of the Manager of Water Operations (i.e., acceptable method of accounting for water is determined).
        ii. The meter must be installed in accordance with the manufacturer's recommendations (instantaneous flow rate and totalizer required).
        iii. Calibration statements are required and must have been obtained by the use of an outside contractor acceptable to MID. Statements must be current (within the last 24 months preceding the wheeling activity).
        iv. If necessary, MID will perform a flow test to properly calibrate a meter.
5. Losses to be Determined by MID.

6. The applicant must make prior arrangements with the appropriate Distribution System Operator (DSO) before any water is wheeled in MID's distribution system.
7. Any temporary modifications to the MID canal system or facilities for wheeling purposes will be paid for by the applicant and will be subject to control and approval by MID.
8. Private well discharges to MID facilities may only be started or stopped with authorization from MID Irrigation Operations. An authorization shall be approved in writing, or any other form acceptable to the MID.
9. All private well pump/motor assemblies shall be safely accessible to MID employees.
10. MID shall have the right to test the water quality for any private well. MID retains the right to terminate groundwater wheeling operations if the private well discharge quality is deemed by MID, to be detrimental to MID operations, canal water quality or operational discharges. Any testing costs shall be solely borne by the applicant.

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2015 Supplemental Water Supply Pool Program Application

MERCED IRRIGATION DISTRICT
WATER & POWER
744 W. 20th Street
P. O. Box 2288
Merced, CA 95344-0288
(209) 722-5764
(800) 750-2720
(866) 825-2474

Date:________________, 2015

Customer Name:________________________________

Customer ID:________________________________

If you are interested in voluntarily purchasing water from the Supplemental Water Supply Pool Program ("Program") in 2015, please complete this Application and return it to MID Customer Service, along with your prepayment, by **Friday, April 24, 2015. Growers that do not submit an application by the deadline will not be eligible for the Supplemental Program.** Water provided by the Program is water made available by conjunctive groundwater pumping. Merced Irrigation District will strive to meet Program participants' water demands as best it can within the constraints of MID's facilities and infrastructure, but MID can make no express guarantees or warranties as to Program water availability either by frequency, rate or duration.

Applicant's signature confirms and acknowledges that:

1. Applicant is requesting to voluntarily subscribe to the Supplemental Water Supply Pool Program in accordance with the general rules of the 2015 Water Management Implementation Plan.

2. Program water will be charged, and Applicant agrees to pay the MID Board of Directors adopted price for Program water of $225.00/Acre-Foot.

3. Prepayment is required for participation. The amount of the prepayment is $50 per acre for listed Water Account parcel acreage. Please complete the worksheet on the back to identify each Water Account and associated acreage/estimated usage for which the Applicant desires to voluntarily purchase Program water.

4. Program water is made available using conjunctive groundwater pumping. Availability is limited due to a variety of factors, including the operational status, location, capacity and depth of groundwater wells. Regardless of the water demands and/or needs of the Applicant, MID makes no guarantee of its ability to deliver any certain volume, flow rate or timing of delivery, or that it will be able to make any delivery at all.

5. MID water supplies will likely be inadequate to grow a full crop of any kind either annual or permanent.

Total Water Account Acreage = ________ acres	**(X) $50 per acre =**	**Required Prepayment:** **$__________**

________________________________ ________________
Applicant's Signature Date

MERCED IRRIGATION DISTRICT
WATER & POWER

2015 Supplemental Water Supply Pool Program Worksheet

Water Account Number	Estimated Usage (for general planning purposes only)	Water Account Acreage
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
	Flow Rate: ____ gpm/cfs (circle one) How Often: Every ___days Per/ week or month (circle one) Duration of Irrigation Event: ______ hours/days (circle one)	
Total Water Account Acreage		__________ acres

Private Groundwater Wheeling Application

MERCED IRRIGATION DISTRICT
WATER & POWER

Tenant may complete for Owner if an existing Owner/Tenant Agreement is on file at MID.

CONTRIBUTING PARCEL

Owner's Name (Please Print): ____________________

If owner is a business, please include name of authorized representative.

Owner/Tenant's Signature:

____

Water Acct #: __________ APN(s): __________ Gross Irrigated Acres: __________

Tenant: ____________________

Address: __________ Phone Number: __________

City, State, Zip __________ Alternate Number: __________

RECEIVING PARCEL

Owner Name (Please Print): ____________________

If owner is a business, please include name of authorized representative.

Water Acct #: __________ APN(s): __________ Gross Irrigated Acres: __________

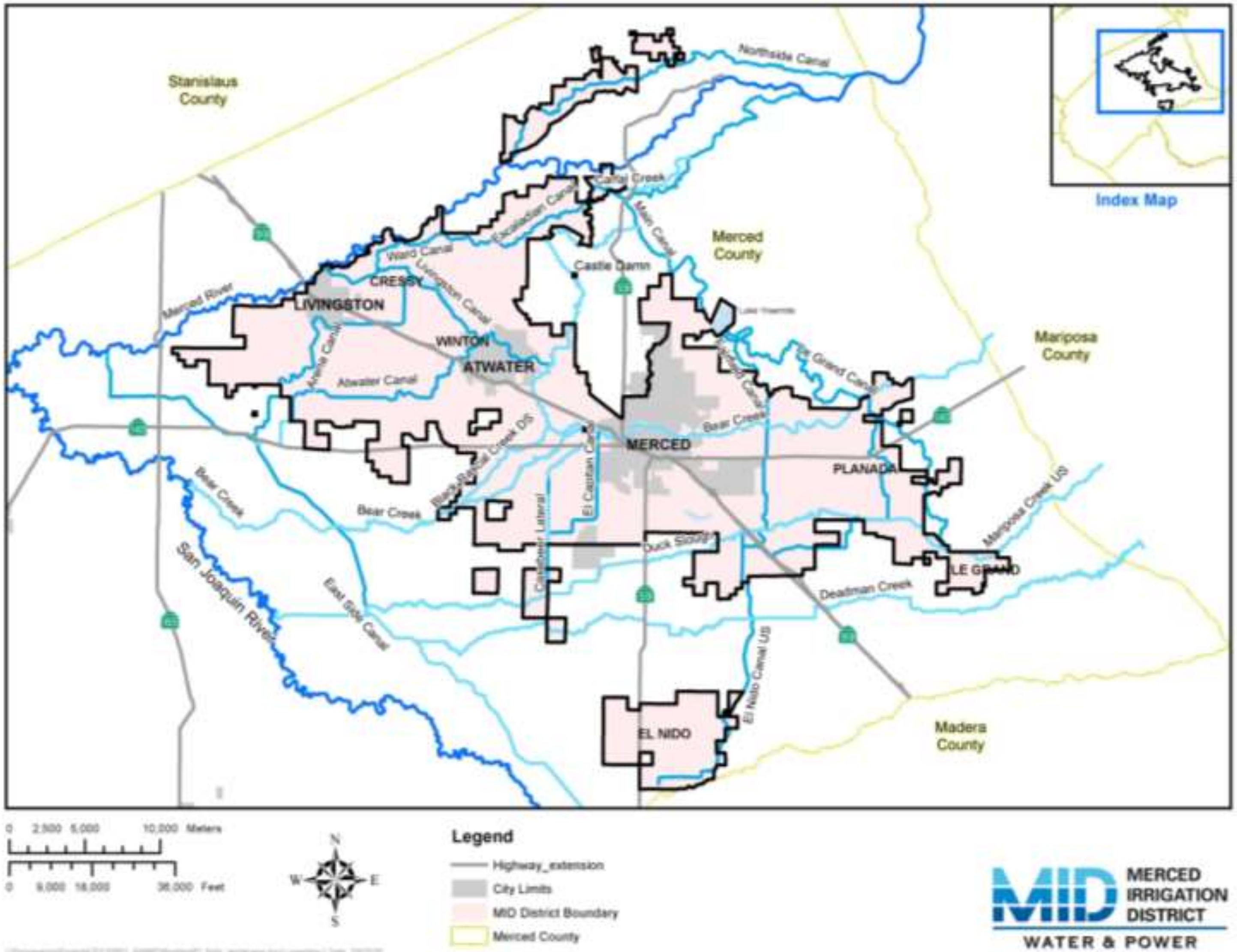
Tenant: ____________________

Address: __________ Phone Number: __________

City, State, Zip __________ Alternate Number: __________

For Office Use Only	**Manager of Water Operations**: ____________________ Approved Yes/No

APPENDIX H
DISTRICT MAP



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