Water Available for Replenishment

Appendix C: Water Available for Replenishment Method Guidance

Introduction to Appendix C

DWR has developed guidance for GSAs to use in their water available for replenishment planning processes. The guidance to assess and plan water available projects or management actions from each water available method can be found in Appendix C. These water available methods include:

- Surface water, including stormwater.
- Water conservation.
- Recycled water.
- Desalination.
- Water transfers.

The guidance dedicated to the *for replenishment* methods can be found in Appendix D. The *for replenishment* methods are separated into two categories.

- Direct recharge, which includes injection wells or spreading.
- In-lieu recharge, which has an indirect recharge effect.

The guidance for each method is presented in three sections. First, the method is defined. Then, information specific to the planning and implementation of the method is described. These descriptions will provide an overview of the planning considerations and references that a GSA may need to think about, or should refer to, when developing projects or management actions. Finally, descriptions of successful projects or management actions that, together, have developed water available for replenishment are provided.

While this report focuses on major method categories, DWR also notes specific management actions listed in California Water Plan Update 2013 that could supplement the surface water method, such as precipitation enhancement; watershed management (including meadow restoration); and other innovative actions. With these types of enhancements, *water available* may be increased.

Appendix C-SW: Surface Water Method Guidance

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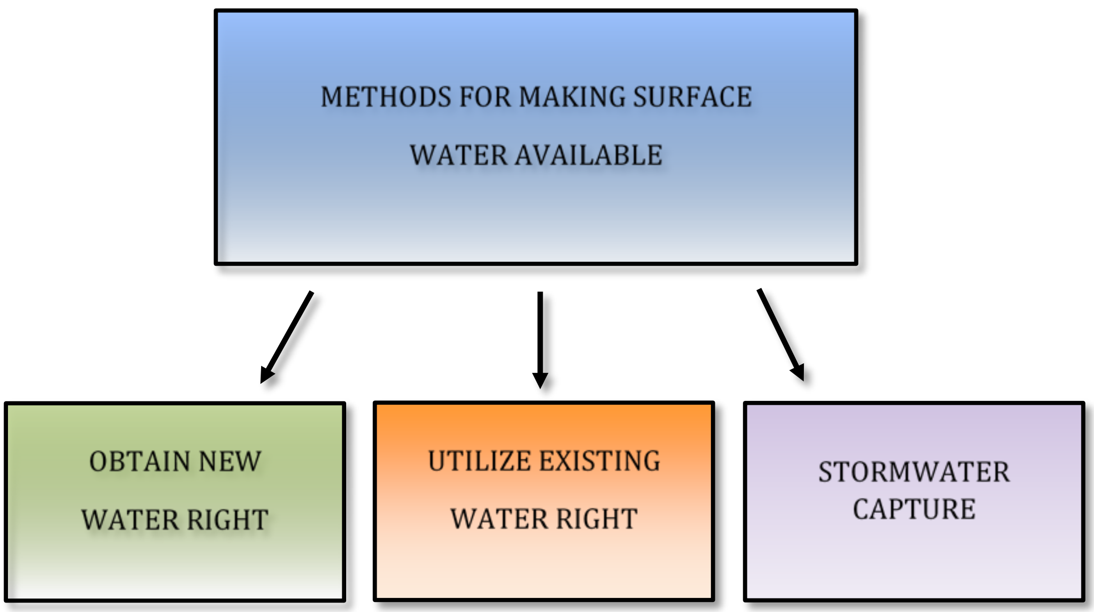
Introduction and Overview

This method guidance presents an overview of three different methods of making surface water available for replenishment of groundwater basins. As discussed in Appendix B, development of projects to make surface water available, such as the Central Valley Project and the State Water Project, has been used to successfully address unsustainable groundwater overdraft. Statewide, numerous locally developed surface storage and delivery projects have been used to slow, and in some cases reverse, declining groundwater levels by providing surface water to areas that previously were heavily reliant on groundwater. New or expanded use of surface water will likely be a component of achieving sustainability in some basins.

The three methods of making surface water available for groundwater replenishment include: use of an existing surface water right, obtaining a new surface water right, and stormwater capture, as shown in Figure C-SW1. Surface water use is typically defined by and subject to conditions specified in a water right permit. Stormwater capture applies to stormwater runoff that has not entered a natural channel and is a source of surface water available that is not currently subject to water right requirements of the California State Water Resources Control Board (State Water Board).

Figure C-SW1. Methods for Making Surface Water Available



Water Rights in California

In most circumstances, a project proponent will need a water right to divert, store, or directly use surface water for replenishment projects. This section provides a brief overview of surface water rights in California.

California recognizes two systems of surface water rights: riparian and appropriative. A riparian right allows a land owner to use a correlative share of the water flowing past their property and is associated with land that touches a natural lake, river, stream, or creek (State Water Resources Control Board FAQs 2015). Riparian rights are normally attached to the riparian parcels and remain with the land when it is sold.

Appropriative rights are required to divert and use water on lands that are not riparian. Appropriative water rights are issued by the SWRCB and administered under the "first in time, first in right" doctrine, meaning the first user of the water has a higher priority than subsequent users. Each user's priority is determined based on the date of filing for a water right

The Water Commission Act of 1914 created the permit process used today; prior to 1914, water was appropriated by posting or filing a notice of the intent to take water and place it to beneficial use. In the early years, this form of appropriation involved posting a notice at the point where water was to be diverted from its source. Later, notices were filed on a voluntary basis with the county recorder. The priority date of these early rights is based on the date of posting or filing, and these rights are generally referred to as Pre-1914 Rights.

The Water Commission Act formalized the appropriation system and centralized appropriative water right records for the state, defined as post-1914 appropriative rights. The Water Commission Act required appropriators to acquire a permit prior to diverting water, and that they provide specific information in their water right application. Water right applications must specify the point at which the water will be diverted (point of diversion), the rate and/or volume of the diversion, the season when the diversion will occur, the beneficial use of the water being diverted, the place where the water will be put to beneficial use (place of use), and whether the water will be directly diverted as it flows naturally in the stream or if it will be diverted to storage, such as in a reservoir or other storage facility.

Key Components of a Post-1914 Water Right:

- **Source of Water**
- **Beneficial Use**
- **Point of Diversion**
- **Rate and/or Volume of Diversion**
- **Season**
- **Place of Use**
- **Direct Diversion or Storage**

California's water rights have a long and often complex history interwoven into the current use and operation of the surface water system. Additional information on the history and administration of water rights can be found on the State Water Board's website at: http://www.swrcb.ca.gov/.

Numerous publications provide greater information on California water rights. Two recommended references are, *Layperson's Guide to Water Rights Law* (the Water Education Foundation 2005), and *Appropriative Water Rights in California* (Archibald 1977).

Considerations for the Use of Surface Water for Replenishment

While each potential groundwater replenishment project under consideration by a GSA is unique, most projects share some common components. The following section highlights the most common considerations for developing a surface water project for replenishment.

Water Rights

In most cases, a water right is required to divert and use surface water, with the lone exception being stormwater capture projects. Subsequent method guidance details the process for either applying for a new water right, or for reviewing and potentially changing existing water rights. Where an existing water right needs to be changed or a new water right is needed, the effects of a new or modified right on the other legal users of water must be considered. Consideration and planning of water rights is essential to making surface water available for replenishment and a significant step in the project planning process.

Need for Replenishment Project

Surface water can be used as either a direct or in-lieu replenishment method to increase groundwater basin replenishment. There are advantages and disadvantages to each method, as described in the replenishment methods guidance. GSAs will need to consider and select the best method for their basin and situation. When developing a surface water project for replenishment, a key consideration is the timing and frequency of when surface water is available. Information in Chapter 4 shows that in most hydrologic regions, surface water is more frequently available during months when water demands are low. This may make direct replenishment projects more preferable to in-lieu projects because surface water is not typically available during periods of higher demands.

Effect on Sustainable Management of the Groundwater Basin Budget

The potential long-term effects of proposed management actions on achieving the sustainability goal for a basin must be considered by ensuring the basin is operated within its sustainable yield. A technical evaluation must be performed to quantify the frequency, timing, and quantity of surface water made available by the project, and the effect of these actions on annual groundwater budgets and the long-term sustainable yield of the basin. The method for making surface water available needs to be coupled with appropriate replenishment measures in order for the project to have a positive effect on the water budget and sustainability goal for the basin. Simply making surface water available to meet water demands within the basin will not result in sustainable groundwater management, as defined and required under the Sustainable Groundwater Management Act (California Water Code Section 10721).

Water Quality

The quality of surface water can influence how it is used, considerations include: the quality of available source water, the water quality criteria for replenishing groundwater, and the water quality needs for any uses that may be served as part of an in-lieu replenishment project. Water quality considerations may largely depend upon the method of replenishment; an in-lieu project may only need to consider the willingness of users to accept the quality of water from a surface water project, while a project that proposes to inject surface water directly into an aquifer may be required to meet stricter water quality standards. This method guidance addresses the use of surface water diverted from fresh water sources and also the capture of urban stormwater runoff before it reaches a natural channel.

Environmental Review

The proposed project's effect on the environment will need to be evaluated. The California Environmental Quality Act (CEQA) requires State and local agencies to identify significant environmental impacts of their actions and avoid or mitigate those impacts if feasible. Environmental review for the use of surface water for replenishment may require the preparation of a CEQA document that includes the effects of the proposed project on public trust resources such as fisheries, navigation, recreation, and ecology. Federal ESAs and requirements of the Clean Water Act will need to be followed. A comprehensive listing of the regulatory and permitting requirements is not provided; requirements will vary based on the type of project being implemented and its location.

Conveyance

A project proponent may need new infrastructure to convey surface water from where it is available to where it can be used to replenish groundwater. Infrastructure may take the form of a new diversion structure or pump on a river or stream. Conveyance may also be a new canal or pipeline for transporting water, or a new dry well or spreading basin for infiltration. In some instances the existing distribution systems may be extended to reach new areas or locate infiltration infrastructure close to existing distribution systems or potentially even use the existing conveyance distribution system as the recharge facility.

Obtaining a New Water Right

Obtaining a new water right permit for the diversion and use of surface water is an involved process that typically takes multiple years. The process begins with the project proponent defining the project and filing an application for a water right permit. After the application is filed with the SWRCB, an opportunity is provided for other water users, agencies, and the public to protest the application, and a chance is given for the involved parties to resolve their complaint. If protests cannot be resolved, the SWRCB will schedule and hold a hearing and issue an order to either approve or deny the application. In addition the application is checked to see if it meets the statutory requirements. The SWRCB Water Rights Applications website provides more detailed information on the sections generally described below (State Water Resource Control Board 2016)

Initial Screening

Development of a surface water project can begin with a review of the regulatory status of the stream or river. If the stream being considered is designated as Wild and Scenic, Fully Appropriated, or has been adjudicated, the project screening and development will be more challenging.

Following the passage of the federal Wild and Scenic Rivers Act by Congress in 1968, the California State Legislature passed the California Wild and Scenic Rivers Act in 1972. State-designated rivers were later protected under the federal act in 1980. The Wild and Scenic River designation is frequently placed on specific river reaches and is rarely applied universally from the headwaters to the terminus. Details regarding the designated reaches and prohibited activities and projects for each river are contained in the acts (National Wild and Scenic River System 2016).

The State Water Board maintains a list of Fully Appropriated Stream Systems, as declared in Water Right Order 98-08. This order added and revised streams previously determined to be Fully Appropriated in Water Right Orders 89-25 and 91-07. All or a portion of a stream system can be designated as “Fully Appropriated” either year-round or during specific periods. For example, Water Right Order 98-08 lists the Sacramento and San Joaquin rivers and all their tributaries as “Fully Appropriated” upstream from the confluence of the two rivers, from June 15 through August 31. Exhibit A of Order 98-08 lists the

Critical Reach of Stream Systems declared by the State Water Board by county, and includes the season when the stream is Fully Appropriated.

Exhibit A of Order 98-08 is located at the following link:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/fully_appropriated_streams/.

Stream adjudication is a judicial proceeding that determines and defines the nature, extent, and relative priority of the water rights. An adjudicated stream is not necessarily Fully Appropriated, but part of the initial screening should check to identify any previous or ongoing adjudicatory processes. The State Water Board maintains a list of adjudicated streams at:

http://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/judgments/

Application to Appropriate Water

A water right application must be completed and submitted to the State Water Board in order to obtain a new permit to divert surface water. The State Water Board provides detailed instructions on completing the forms and filing the application for a water right permit in an instructional booklet available at:

http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/app_instruction_booklet.pdf.

To complete the application form for a project, the proponent must perform a significant level of analysis, research, and initial project design. A key component of the application form is the Water Availability Analysis (WAA). The WAA is used "to demonstrate a reasonable likelihood that unappropriated water is available for appropriation" (California Water Code Section 1260(k)). A WAA must demonstrate there is water available at the proposed project's point of diversion, within the watershed, in consideration of existing rights, and in consideration of in-stream beneficial uses.

The key components of a WAA, as referenced in the SWRCB's Water Availability Information (State Water Resources Control Board 2016), include:

- Project description.
- Physical availability of water.
- Analysis of senior water rights.
- Analysis of in-stream beneficial uses and public trust resources.

An Application to Appropriate Water includes:

- **Project description.**
- **Purpose of use, diversion/storage amount, and season.**
- **Source of water and points of diversion and re-diversion.**
- **Water Availability Analysis (see below).**
- **Place of use.**
- **Project schedule.**
- **Justification for the amounts requested.**
- **Diversion and distribution method.**
- **Conservation and monitoring.**
- **Environmental documents and permitting information.**
- **Filing fees.**

Project Description

The project description also includes information needed for the application including the project location, the point of diversion, and a description of the project operations. The operational description should include when diversions would occur, the rate of diversion, and volume of water that may be diverted. The operational description should also include information on whether the water would be diverted and directly placed to beneficial use, or be stored prior to being placed to beneficial use.

Water held in storage for later application for beneficial use differs from a direct diversion where water is diverted and directly applied to a beneficial use. *Storage* includes diversion of water to underground storage, not just storage in surface reservoirs. For example, a project that diverts surface water for groundwater replenishment through in-lieu recharge is likely to be directly diverting water for a beneficial use that would otherwise be met from groundwater. Conversely, a project that diverts surface water for groundwater replenishment in spreading basins is storing the water until it is extracted through groundwater pumping for a beneficial use, such as irrigation, domestic, or municipal uses.

Physical Availability of Water

A WAA prepared for new water rights must include an analysis of the physical availability of water at the project's point of diversion and within the watershed of the project. A variety of methods are available for completing a WAA, but all methods must evaluate the amount of water available <u>at the proposed point of diversion</u>. By comparison, estimates of the water available for replenishment provided in Appendix A were completed at or near the points of outflow at the hydrologic region or planning area. The level of analysis used for hydrologic region WAFR estimates is not adequate for the purpose of a WAA in support of a new water right application.

A WAA may use existing stream gage data (see the United States Geological Survey or the Department of Water Resources California Data Exchange Center for available gages) or a computer model of the watershed and stream. Acceptable models may span a wide range of complexity and associated costs, from relatively simple and inexpensive to highly complex and costly. No predefined standard must be met; however, the level of analysis must be sufficient to demonstrate the amount and timing of when unappropriated water is available. An analysis of annual volumes of available water does not provide sufficient evidence to support a water right application, because water may only be available during a portion of a year. Numerous sources of existing data are available to support the development of watershed models, including precipitation and stream flow records, land use and diversion data, and watershed or property boundary data. A good source of data is the USGS's National Hydrography Dataset (http://nhd.usgs.gov/). Existing models may be used or modified for the purpose of performing a WAA.

When determining the physical availability of water, it may be necessary to consider flows for both impaired (affected by dams, diversions, returns flows, water diverted into or out of the watershed) and unimpaired (natural flow of the stream without upstream impairments) conditions. The SWRCB is developing draft flow objectives for Delta tributaries based on a percentage of unimpaired flow in fulfillment of the 2009 Delta Reform Act. While unimpaired flows are useful for understanding the requirements for in-stream beneficial uses, impaired flows are what actually exists and can be used to show conditions, both with and without the proposed project. The need to calculate both an impaired and unimpaired condition may drive the technical approach for performing the WAA.

Analysis of Senior Water Rights

A WAA must consider existing senior water rights upstream and downstream of the proposed project. Water flowing past a proposed point of diversion does not, in and of itself, demonstrate that water is available for appropriation. That water may be needed to satisfy a senior downstream right, or an existing environmental requirement. A WAA must show that unappropriated water is physically available at the proposed project's point of diversion.

The analysis of existing water rights must consider all rights, including riparian and appropriative, pre-1914, post-1914 rights, and pending applications. General information on existing water rights is available on the State Water Board's electronic water right information management system (eWRIMS). eWRIMS combines a tabular database on existing permits, licenses, and claims with GIS data to provide a searchable database of existing water right information. Information contained in eWRIMS is a good starting point for understanding existing water rights on a stream or within a watershed. In many cases, a more detailed review of the actual permits and licenses will be necessary to complete the WAA for a new project. More information on water rights permits contained in eWRIMS can be found on the State Water Board's website at:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml.

The State Water Board has recently made available reported diversion and water use information that can provide data on how water rights have been exercised through the eWRIMS database (State Water Resources Control Board 2016). Recent diversion and use reporting requirements, implemented in part due to drought conditions, have included increased reporting requirements for many pre-1914 and riparian claims. This information may be useful toward understanding how reported water use compares with the permitted or licensed "face value" diversion rates and quantities provided in eWRIMS. Nonetheless, reported water use values must be considered in the context of the hydrology, regulations, and other factors for the year being reported. For example, the reported use values for 2014 and 2015 reflect the curtailment of appropriative water rights due to limited precipitation and snowpack runoff.

Analysis of In-stream Beneficial Uses and Public Trust Resources

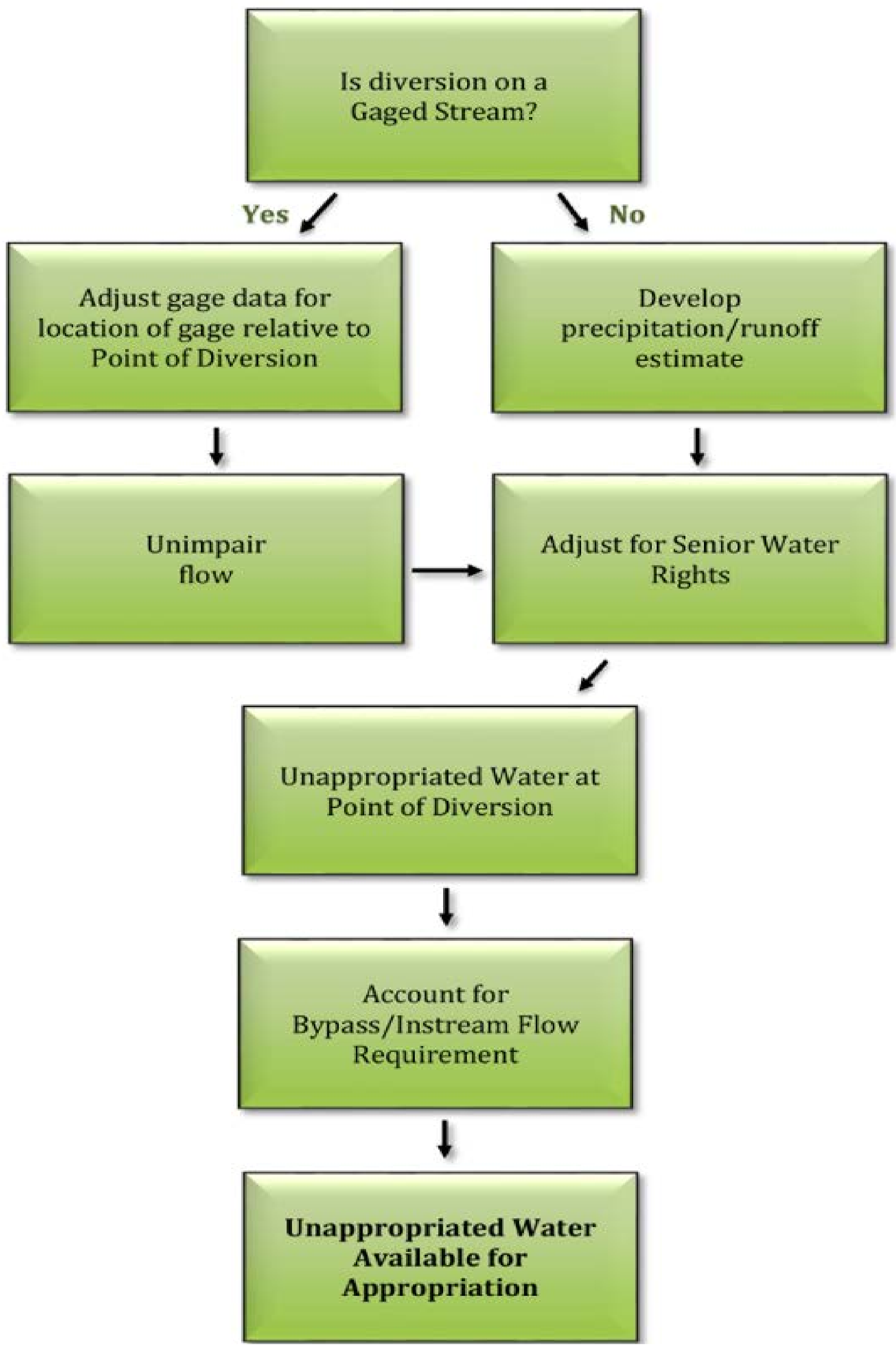
Water Code Section 1243 states, "…*in determining the amount of water available for appropriation, the SWRCB shall take into account, whenever it is in the public interest, the amounts of water needed to remain in the source for protection of beneficial uses...*" The State Water Board will consider the water needed to protect public trust resources, including fish and wildlife habitat and recreation.

There are existing in-stream requirements and information on public trust resources for many streams and rivers. Information on existing in-stream beneficial uses can be found in the terms and conditions of existing water right permits and licenses. State Water Board decisions and orders also may describe previous analyses or considerations of in-stream beneficial uses. A review of existing listed species and designated critical habitat, likely conducted as part of the required CEQA analysis, may also provide information on the need to consider in-stream uses.

In areas where little existing information is available, the State Water Board has used a cumulative flow impairment index (CFII) as one method to understand the impairment level of a stream. The National Marine Fisheries Service and the California Department of Fish and Game have developed guidelines for in-stream flows on central coast streams (National Marine Fisheries Service and California Department of Fish and Game 2002) applied by the State Water Board. As part of the WAA, a project proponent may choose to conduct their own analysis of in-stream flow needs for the protection of public trust resources. Collaborating with natural resource agencies very early in the process of determining beneficial use would aid in this process.

The following flowchart, Figure C-SW2, provides an overview of the major steps for performing a Water Availability Analysis. The State Water Board provides an example of a WAA on their website at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_availability/.

Figure C-SW2. OVERVIEW OF WATER AVAILABILITY ANALYSIS



Environmental Documentation

An environmental assessment is a necessary part of an application to appropriate water. A determination of the appropriate lead agency will be necessary, and then that agency will be responsible for conducting the environmental review. Depending on the nature of the project, an environmental impact report may be required.

Water Right Permit Process

Filing an application with the State Water Board begins the formal process for the project proponent to obtain a water right. The State Water Board will either notify a project proponent that an application has been accepted or is incomplete within 30 days of filing the application. The State Water Board will then notice the application and receive protests from the public regarding the application. An applicant may attempt to negotiate with protestors to dismiss any objections. Any unresolved protests are addressed during a State Water Board hearing when the board considers the application, protests, and any staff-developed information and recommendations to determine whether or not to issue a permit.

Upon issuance of a permit to divert water, a project proponent would then obtain any other necessary permits to construct and operate the project. A permit to divert water contains terms and conditions that define the amount of water to be diverted from the source, the maximum rate of diversion, the purpose and place of use, and the season when water may be diverted. The permit will also include a development period for the project proponent to construct and operate the project, and demonstrate beneficial use of water required under the permit. The permit may also contain other terms and conditions for the protection of senior water rights and public trust resources.

Temporary Permits for Groundwater Recharge and Storage

In November of 2015, Governor Brown issued Executive Order B-36-15, requiring the State Water Board to prioritize temporary water right permits for groundwater recharge and storage to enhance the ability of local or State agencies to capture high precipitation events for local recharge. This temporary program was in response to drought conditions and intended to help the State Water Board gather information needed to develop a comprehensive program for permitting groundwater recharge of high flows. Temporary permits can be obtained significantly faster as a result of the expedited review and approval process and the current CEQA exemption provided by the executive order. While the relative ease of obtaining a temporary permit makes them more desirable, the temporary permits are valid for a period of 180 days. These permits may be useful to investigate pilot projects or under certain conditions.

Before approving a temporary permit for groundwater recharge and storage the State Water Board must find that:

- **The applicant has an urgent need for the water.**
- **There will be no injury to any lawful user of water.**
- **There will be no unreasonable effect upon fish, wildlife, or other instream users.**
- **The proposed diversion and use are in the public interest.**

In 2016, the State Water Board issued two temporary permits to the Scott Valley Irrigation District and Yolo County Flood Control and Water Conservation District. These temporary permits allowed for the diversion of surface waters to underground storage, include monitoring requirements, and defined the eventual beneficial uses of water stored within the basins within a demarcated place of use.

More information on the State Water Board's application process, including applications for temporary permits, can be found on their website at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/groundwater_recharge/.

Example Project

The Woodland-Davis Clean Water Agency is a joint powers authority between the cities of Woodland and Davis, created to implement and oversee a regional surface water supply project. The regional project will augment groundwater supplies with surface water supplies to meet stricter drinking water quality and wastewater discharge regulations (Woodland-Davis Clean Water Agency website 2016). The Woodland-Davis Clean Water Agency applied for and was granted a water right to divert surface water from the Sacramento River. More information on the project can be found on the Agency's website at: http://www.wdcwa.com/.

Use of an Existing Water Right

An existing water right permit, license, or pre-1914 statement may be changed to make surface water available for groundwater replenishment. An example may be an irrigation district with surface water rights using surface water in lieu of pumping groundwater. This example project may be permitted to further conjunctive management as long as the terms, conditions, and limitations within the existing water rights are followed.

It is necessary for the water right holder to petition the SWRCB for changes to the water right when one or more of the components that define a water right permit or license are changed (see the "Key Components of a Post-1914 Water Right" text box for more information). The change petition process can either be simple or complex, depending upon the rights being changed and the changes being sought. In some instances, it may be necessary to complete many of the same steps required for new water right permits. For example, adding a new beneficial use to the water right may necessitate a WAA and effects on return flows for senior water right holders and instream beneficial uses. Surface water diversions for the purpose of replenishment may include storage if the water is not being replenished through in-lieu recharge methods. Storage in underground aquifers is a method of diversion, not beneficial use, and analysis must extend beyond storing the water underground to show the ultimate beneficial use of the stored or recharged water. When changing an existing right, it is important to demonstrate that the change will not be an expansion of the original water right, including: additional water being diverted, a higher rate of diversion, or new season of use.

Example Projects

There are numerous example projects where an existing water right is changed to improve the management of a groundwater basin. The majority of these projects are conjunctive management projects that coordinate the management of surface water and groundwater resources to meet demands. A summary of conjunctive management projects in the state can be found in Appendix D to California's Groundwater Update 2013 located on DWR's website at: http://www.water.ca.gov/waterplan/topics/groundwater/index.cfm.

Stormwater Capture

Traditionally, urban stormwater management has treated runoff as a flood management problem in which water needs to be conveyed as quickly as possible from urban areas to waterways in order to protect public safety and property. Historically, stormwater regulations have focused on water quality considerations. The federal Clean Water Act and National Pollutant Discharge Elimination System (NPDES) permits define standards and regulations for stormwater discharge.

Water managers now recognize that stormwater can be viewed as a resource. This change in thinking is illustrated in the Los Angeles Department of Water and Power's Stormwater Capture Master Plan. The first objective for the plan is to describe "the long-term potential of stormwater to contribute to the City of Los Angeles' water supply" (Los Angeles Department of Water and Power 2015). According to the Los Angeles Department of Water and Power (LADWP) 2015 plan, current annual stormwater capture in Los Angeles is approximately 64,000 acre-feet, and is comprised of 35,000 acre-feet from incidental capture through passive infiltration from pervious areas and 29,000 acre-feet of active capture from existing projects. Over the next 20 years, LADWP estimated that "an additional 68,000 to 114,000 acre-feet per year could be realistically captured through a suite of projects, programs, and policies" associated with stormwater capture (Los Angeles Department of Water and Power 2015).

Water Quality Concerns

In some instances, the use of stormwater for groundwater replenishment may require pretreatment before infiltration. Urban runoff may contain chemical constituents and other organisms that could impair water quality. It may be necessary to remove these constituents or treat the water before injecting or infiltrating the water into aquifers to prevent introducing pollution into the groundwater system. Studies by the U.S. Environmental Protection Agency (Environmental Protection Agency 1983) and the U.S. Geological Survey (Schroeder 1993) indicate that all monitored pollutants stayed within the top 16 centimeters of the soil in recharge basins. The actual threat to groundwater quality from recharging urban runoff depends on several factors, including soil type, source control, pretreatment, solubility of pollutants, maintenance of recharge basins, current and past land use, depth to groundwater, and the method of infiltration used.

The State Water Board is currently collaborating with stakeholders to identify effective ways to expand the statewide stormwater program that recognizes stormwater as a valuable resource (SWRCB website, 2016). This program addresses the use of stormwater to enhance local water supplies and developed a list of proposed actions to achieve the State Water Board's goals. Proposed actions include support for stormwater capture and use, and identifying and eliminating legal and technical obstacles to stormwater capture and use. More information is available on the State Water Board's website at: http://waterboards.ca.gov/water_issues/programs/stormwater/strategy_initiative.shtml.

Stormwater Capture Programs

There are multiple different methods for capturing stormwater that can be used for replenishment and a variety of different technical approaches. Methods for recharging groundwater with urban runoff include: routing roof runoff to vegetated areas; draining runoff from parking lots, driveways, and other paved surfaces into landscaped areas with permeable soils; using dry wells and permeable surfaces; and collecting and routing stormwater runoff to basins. These methods can generally be categorized as on-site (individual homes, buildings, or parcels) or sub-regional (neighborhoods or areas) projects that aim to either directly use captured stormwater or infiltrate stormwater into the underlying aquifer.

Example Projects

Urban stormwater infiltration projects have been developed in California and other western states. These projects are typically developed in areas where water supplies are limited and/or expensive. The Fresno-Clovis metropolitan area built an extensive network of stormwater retention basins that not only recharge more than 70 percent of the annual stormwater runoff (17,000 acre-feet) but also uses excess snowmelt from the Sierra Nevada for recharge, when available. Agencies in the Santa Ana watershed recharge approximately 78,000 acre-feet of local storm runoff a year. Outside of California, the City of Phoenix began programs in the early 1970s to require new developments to capture, retain, and infiltrate storm events primarily through the use of dry wells (The Water Report 2015).

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Appendix C-C: Conservation Method Guidance

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Overview

Water conservation is defined by California Water Code Section 10871 as "the efficient management of water resources for beneficial uses, preventing waste, or accomplishing additional benefits with the same amount of water." The two most critical factors in determining the amount of conserved water which can contribute toward replenishment of groundwater are (1) the net impact of conservation measures on the groundwater basin water budget, and (2) the legal status (principally, water rights) of reductions in surface water diversions that could potentially be used for replenishment.

Water conservation is a key component of water management in California and can potentially make water available for other purposes, including groundwater replenishment. This method guidance describes various methods of water conservation for both urban and agricultural uses. The method guidance also relates water conservation strategies to making water available for replenishment, and describes issues and technical considerations for groundwater sustainability agencies that may consider water conservation in a portfolio of options for sustainable groundwater management.

Considerations for All Conservation Projects

There are numerous methods for conserving water in both the agricultural and urban sectors, each with their own unique considerations for groundwater replenishment. A common project consideration involves the effect of conservation projects on making the conserved quantity of water available for groundwater replenishment. In some instances an acre-foot of conserved water may make an acre-foot of water available for replenishment; in other instances the water available may be less.

Source of Conserved Water

Water conservation projects that reduce demand for water supplied from groundwater are different than those that reduce demand for surface water. For example, installing low-flow showerheads in a residential area may help reduce the demand for water. If demand in this area is met from groundwater, the reduction in demand translates into a reduction in groundwater pumping, and a one-for-one effect on groundwater replenishment. The same project implemented in an area that is only served from surface water results in less water being diverted from a stream or reservoir, and likely less water being returned to the surface water system. The water not consumptively used from the surface water system may be available for groundwater replenishment, but an associated replenishment project would be needed to get the conserved water into the aquifer system through in-lieu or active recharge. Additionally, an assessment of the legal status (water rights) of any reductions in surface water diversions resulting from conservation efforts will be necessary when considering the use of this water for replenishment.

Need for Replenishment Project

Water conservation efforts may need to be coupled with a groundwater replenishment project to have a positive effect on a basin's groundwater budget. Generally, projects that conserve surface water may not improve the groundwater budget without an associated replenishment project. There are numerous options for replenishment projects including, delivering conserved water to areas of the basin where demand would otherwise be met with groundwater pumping, or actively recharging aquifers with injection wells or spreading basins.

Effect on Sustainable Management of the Groundwater Basin

In the context of sustainable groundwater management, a key consideration for any water replenishment project is the potential effects of proposed management actions on achieving the sustainability goal for the basin, by ensuring the basin is operated within its sustainable yield. A technical evaluation must be performed prior to project implementation to quantify the frequency, timing, and quantity of conserved water made available, and the resulting effect of these actions on the annual groundwater budget and the longer-term sustainable yield of the basin. The method for making conserved water available also needs to be coupled with appropriate replenishment measures in order for the project to have a positive effect on the water budget and sustainability goal for the basin.

Water conservation projects must be analyzed in order to understand the total effect on the water budget. In some cases implementing water conservation projects may reduce the amount of water percolating into a groundwater basin. An example may be agricultural water use changing from flood irrigation to drip irrigation. This change in irrigation method may make more efficient use of water resources; but, aquifer recharge from applied water may be reduced. This reduction in recharge may have a negative effect on the basin water budget unless the reduction in applied water is coupled with a replenishment project to make up the difference. Similarly, a change from using flood irrigation in areas supplied by groundwater may not have a one-for-one effect on the water budget as some of the groundwater previously pumped for flood irrigation may have returned to the aquifer as deep percolation. The total effect on a basin’s water budget must be considered in the analysis of water conservation projects to quantify the long-term replenishment of the basin or sustainable groundwater management as defined and required under the Sustainable Groundwater Management Act (California Water Code Section 10721).

Dedicating Urban Water Conservation to Replenishment

Competition for water made available from conservation projects in urban areas is likely, and some or all of the conserved water may be dedicated to purposes other than groundwater replenishment. Urban water management plans routinely include water conservation to assist with management through drought periods, and to meet increased future demands, and have proven successful in accomplishing both objectives. When considering water conservation as a method of making water available for replenishment, existing plans for conservation projects and the use of any conserved water from those plans should be reviewed. Additionally, urban water conservation during drought periods may be mandated (Executive Order B-37-16), or at least planned (20 x 2020 Water Conservation Plan), which could limit water available for replenishment during drought.

Agricultural Water Conservation

There are numerous studies on potential water savings from agricultural water conservation in California. Improving efficiencies in agricultural water management has a long history of requirements and regulations. The Agricultural Water Suppliers Efficient Water Management Practices Act of 1990, and the federal Central Valley Project Improvement Act of 1992, established guidance for improving agricultural water use efficiency. Under Assembly Bill 3616, the Agricultural Water Management Council was formed in 1996. It assisted water suppliers with planning and implementation of cost-effective, efficient water management practices until its dissolution in 2013.

As part of a comprehensive package of water legislation in the 2009-2010 legislative session, the Agricultural Water Management Planning Act (Part 2.8 of Senate Bill [SB] X7-7) requires agricultural water suppliers who provide water to 10,000 or more irrigated acres, to develop and adopt an agricultural water management plan (AWMP) with specified components, and implement cost-effective efficient water management practices (EWMPs). SB X7-7 mandates certain actions take place that are intended to improve agricultural water use efficiency. Additional information on the background, implementation, and current state of the requirements in SB X7-7 can be found on DWR's website at:

http://www.water.ca.gov/wateruseefficiency/sb7/

Additional information and references for agricultural water use efficiency and conservation can be located in Volume III, Chapter 2 of *California Water Plan Update 2013*.

This method guidance divides agricultural water conservation projects into two categories: conveyance system improvements and field-level improvements. The following sections describe considerations for both types of conservation projects.

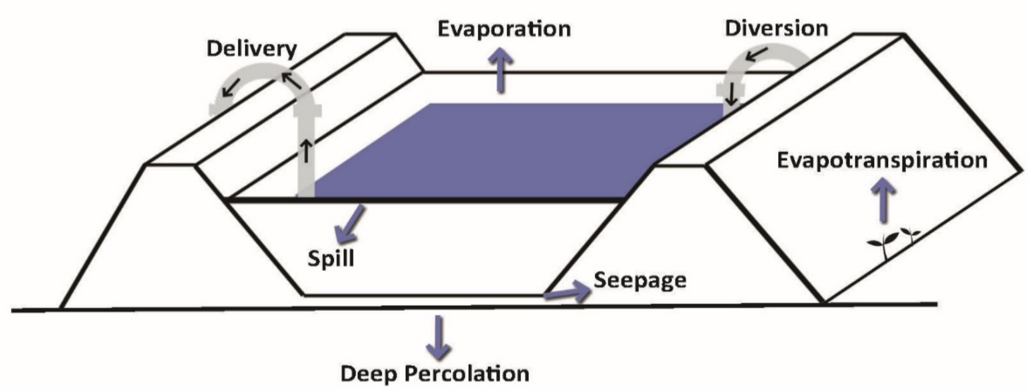
Conveyance System Projects

The delivery of irrigation water to fields where crops are grown often includes conveyance systems such as canals, check structures, regulating reservoirs, and other infrastructure. Conveyance systems are more necessary for the delivery of surface water than for delivering groundwater where wells are typically located close to fields.

Water conservation projects that focus on conveyance systems can include lining canals, vegetation management along canals, installation of supervisory control and data acquisition systems, and construction of regulating reservoirs. These projects can have either a positive or negative effect on a basin water budget.

Figure C-C1 illustrates flow paths for an unlined canal system to show how an existing canal may affect a basin water budget. Water conservation projects that affect these flow paths may or may not improve the basin's water budget.

Figure C-C1. Conveyance System Flow Paths



Conveyance system projects that reduce seepage, evaporation, or evapotranspiration from vegetation along canals, or spillways may make water available for replenishment. These projects improve the efficiency of water delivery through the conveyance system and can reduce the diversion from a surface water body into the conveyance system. The water not diverted into the conveyance system may be available for replenishment, depending on the legal status (water rights) of the amount of reduced diversion. A replenishment project will be necessary to get the water made available by changing these flow paths into the aquifer system.

Conveyance system projects, such as lining canals or reducing seepage, that contribute to deep percolation may have a negative effect on a basin's water budget, while improving delivery efficiency. There can also be environmental effects that must be considered with conveyance system projects that may reduce or eliminate existing habitat along existing conveyance systems.

Example Project

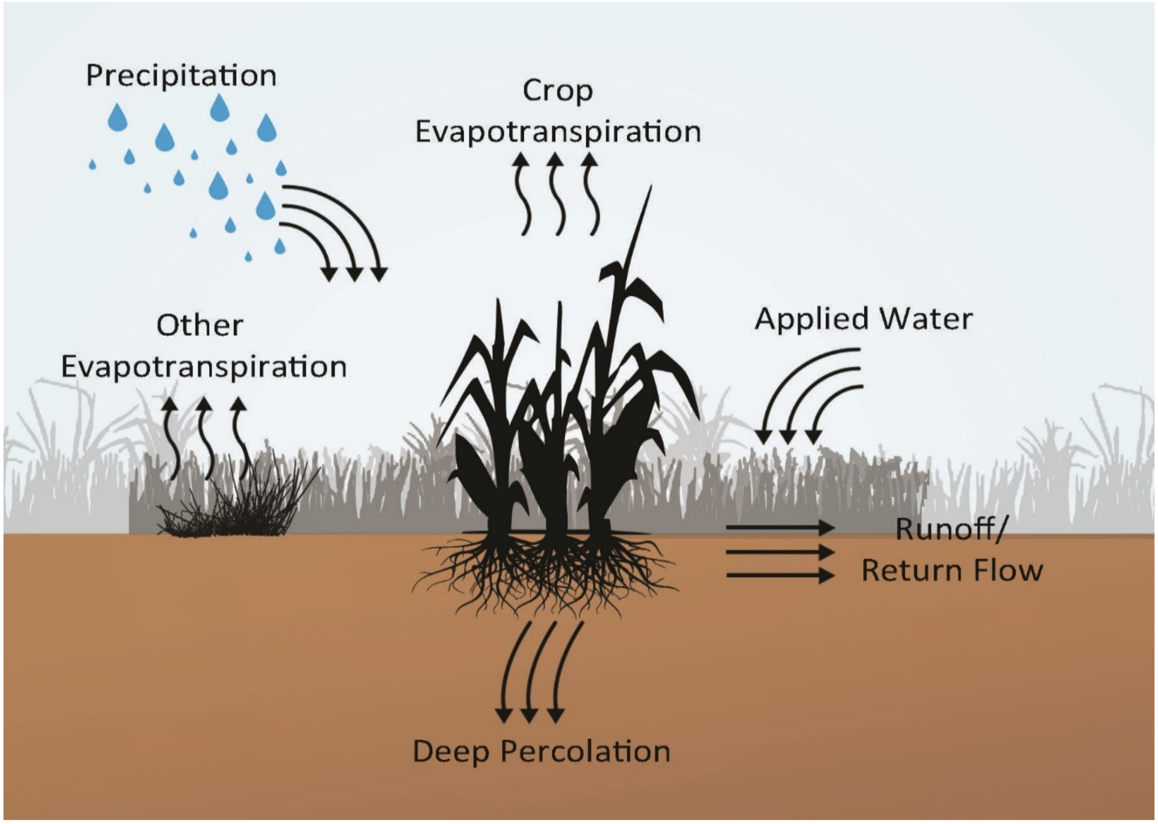
In 1990, Brown's Valley Irrigation District conserved water under their pre-1914 water rights by implementing the Upper Main Water Conservation Project. The Upper Main Water Conservation Project constructed a pipeline to deliver water from Collins Lake to serve the area previously served from the Upper Main Canal that diverted water from upstream of Lake Englebright. The Upper Main Canal was approximately 20 miles long and was replaced with a piped system. Brown's Valley Irrigation District quantified the consumptive-use savings resulting from the water conservation project in a 2002 report, *Analysis of Water Conserved Under the Upper Main Water Conservation Project*.

Field-level Projects

A variety of different field-level projects can be implemented to conserve water. Example projects include changes in irrigation methods, deficit irrigation, and weed suppression.

Figure C-C2 illustrates flow paths for water at the field-level. Water conservation projects that affect these flow paths may make water available for replenishment. Conservation projects that reduce the deep percolation of applied water or reduce return flows that may be reused in another part of the basin may not make water available for replenishment.

Figure C-C2. Field-Level Flow Paths



Projects that conserve water through a more efficient irrigation method typically reduce the water applied to a field. In most cases, the full evapotranspiration of the crop is met and reductions in applied water result in reductions in return flow and/or deep percolation. In order to have a positive effect on the groundwater basin, these projects need to be coupled with an associated replenishment project to recharge the groundwater with the applied water savings. An analysis of the effects on the regional water budget is needed for any field-level conservation project. Conserved water must be quantified and then evaluated to determine the resulting effect on the groundwater budget.

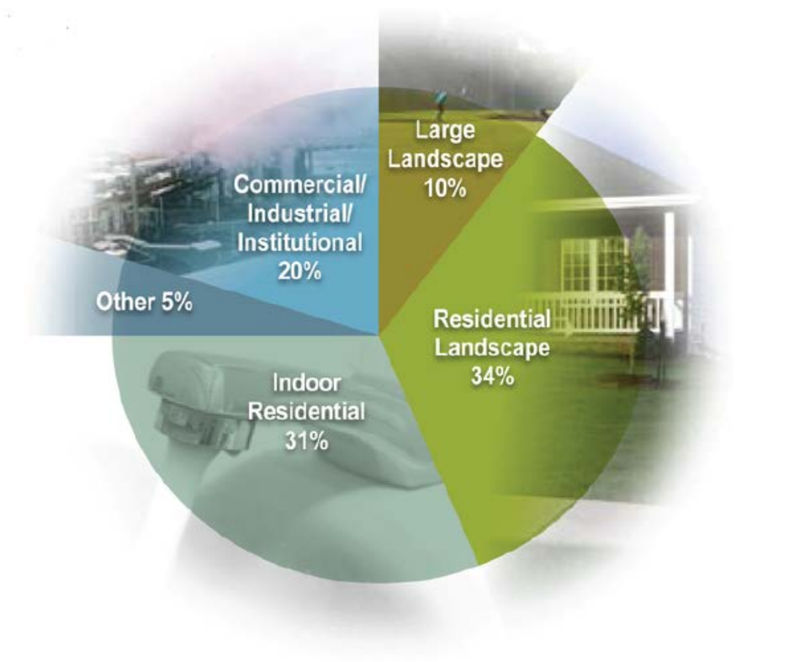
Urban Water Conservation

Over the past few decades, Californians have made great progress in improving urban water use efficiency. Urban water suppliers continue to work toward the SB X7-7 requirement to reduce urban per-capita water use by 20 percent by 2020. Experiences learned during the most recent drought have shown the potential opportunities for changes in urban water use and even more significant conservation.

Groundwater sustainability is another potential driver for urban water conservation. Urban areas in high- and medium-priority basins that rely on groundwater may expand conservation measures to reduce groundwater extractions. Urban areas with access to surface water supplies may be able to make water available through conservation that may assist in managing groundwater basins.

Figure C-C3, reproduced from the *California Water Plan Update 2013*, shows the breakdown of statewide urban water use by various urban sectors. The average annual volume of water supplied for that period was 8.8 million acre-feet. Understanding the total urban water use by the various sectors is useful for understanding the potential to make water available through urban conservation.

Figure C-C3. Statewide Urban Water Use: Eight-Year Average, 1998-2005



The following sections describe potential conservation projects, by areas of urban water use. These projects may make water available for replenishment. Additional information on water conservation by the urban sector is available in Volume III, Chapter 3 of *California Water Plan Update 2013*.

Residential Landscape

As illustrated in Error! Reference source not found., residential landscape is the largest area of urban water use in the state, though it varies considerably by region. There are numerous opportunities to conserve water currently used in residential landscapes including, but not limited to, maintenance of irrigation systems, irrigation audits to identify deficiencies, development of landscape water budgets, and selection of low-water-using plants. Each of these projects may have a different effect on a basin's water budget. Reductions in landscape water use can reduce the volume of groundwater extraction, or may make water available for other purposes, including groundwater replenishment.

The Residential Runoff Reduction Study (Municipal Water District of Orange County and Irvine Ranch Water District 2004) demonstrated that a combination of evapotranspiration controllers and user education can reduce irrigation runoff by 50 percent compared to pre-study conditions. More information can be found at:

http://www.mwdoc.com/documents/R3Study-FINALREVISED10-28-04.pdf

Residential Indoor

Indoor residential water use accounts for approximately 31 percent of total urban water use in California (**Error! Reference source not found.**). The effect of residential indoor water use on the water budget is typically different from outdoor use. In most situations, residential indoor use does not contribute to groundwater replenishment as return flows are consolidated, treated, and discharged back to the surface water system. An exception may be small municipalities or rural residences that rely upon septic systems and drain fields to treat and discharge waste water from indoor residential uses that may contribute to groundwater recharge.

Because return flows from residential indoor use generally remain in the surface water system, conservation projects that reduce residential indoor use either reduce groundwater extractions for areas supplied from groundwater, or need an associated replenishment project to have a positive effect on the groundwater budget.

Commercial, Industrial, and Institutional

The commercial, industrial, and institutional (CII) sectors cover a broad range of water uses, from schoolyard playgrounds and drinking faucets to bottling plants and restaurants. Because CII includes a wide range of water uses, it is a challenge to make generalizations about CII water use as a whole, or finding detailed data on any particular use. Water conservation projects in the CII sector must quantify the effect of conservation on the water budget, including how conserved water contributes to the groundwater basin either through reductions in extraction or increased replenishment.

Large Landscape

Large landscapes are CII landscapes that have a dedicated irrigation meter for their water use. Opportunities for water conservation in large landscapes are similar to those found in residential landscapes. Water conservation in large landscapes may be a method to make water available for groundwater replenishment, but the effect on the water budget must be quantified for inclusion in basin budgets.

Alternative Water Sources

Developing alternative water supplies for urban water use can be considered a method of conserving water in that it reduces demand for urban water from regional suppliers. The primary alternative supply sources are rainwater capture and gray water reuse. Rainwater capture can also be considered stormwater capture that is described in more detail in the method guidance for making surface water available for replenishment.

On-site rainwater capture, in the form of rain gardens, bioswales, pervious surfaces, and other landscape features, can reduce the amount of potable water needed for irrigation, or be used as a supply for indoor non-potable uses. Some rainwater capture projects can be designed specifically to aid in groundwater replenishment. Gray water reuse systems can utilize water from appliances, such as clothes washers, for non-potable uses such as landscape irrigation.

Both rainwater capture and gray water reuse have the potential to reduce demand for potable water. In areas that are supplied from groundwater, these demand reductions have a positive effect on the water budget and can assist in achieving sustainable groundwater management. In areas that are supplied using surface water, the use of alternative sources can make surface water available for other purposes, including groundwater replenishment.

References and Sources of Additional Information

California Department of Water Resources (DWR). 2014. *Commercial, Institutional and Industrial Task Force Water Use Best Management Practices Report to the Legislature.* Sacramento (CA). Volumes 1 and 2.

Executive Order B-37-16, (https://www.gov.ca.gov/docs/5.9.16_Executive_Order.pdf)

Irvine Ranch Water District. 2011. *California Single Family Home Water Use Efficiency Study*. Prepared by: DeOreo W, Mayer P, Matien L, Hayden M, Funk A, Kramer-Duffield M, Davis R, Henderson J, Gleick P, and Heberger M.

Los Angeles Department of Water and Power. 2010. *Urban Water Management Plan 2010.*

Municipal Water District of Orange County and Irvine Ranch Water District. 2004. *The Residential Runoff Reduction Study.*

Salmon Protection and Watershed Network. 2010. *10,000 Rain Gardens Project. A report to the Marin Municipal Water District.*

SWRCB, February 2010, 20x2020 Water Conservation Plan, http://www.swrcb.ca.gov/water_issues/hot_topics/20x2020/docs/20x2020plan.pdf

Appendix C-R: Recycling Method Guidance

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Overview

The California Water Code (CWC) Section 13050(n) defines recycled water as "*water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore [sic] considered a valuable resource*". The CWC definition specifically states that the water has been treated and is therefore able to be reused. As such, this method guidance focuses on the use of water that has been treated at a municipal wastewater treatment facility. The reuse of agricultural return flows or graywater, both of which are typically untreated, or internal industrial reuse are not addressed in this method guidance.

Recycling treated municipal wastewater increases the usefulness of water by reusing some or all of the existing wastewater stream that would otherwise be discharged to the environment as waste by redirecting the water to another local direct application. Recycling municipal wastewater can:

- Increase local water supply if discharges into oceans and inland saline waters are reduced.
- Conserve higher-quality source water for appropriate uses.
- Replenish groundwater resources.

The two most common direct applications of recycled water being used for groundwater recharge are:

- Directly recharging groundwater basins with a facility or program permitted by the State Water Resources Control Board (State Water Board) Division of Drinking Water (DDW) or one of the nine regional water quality control boards (RWQCB).
- Indirectly (in lieu) recharging groundwater basins by replacing groundwater that would be extracted from a basin to meet a local demand with recycled water.

The State Water Board, in collaboration with DWR, conducted a survey of municipal wastewater recycling in 2009 (a survey of 2015 recycled water use is currently underway) and published the results on its website. The survey identified approximately 669,000 acre-feet of municipal recycled water that were beneficially reused in that year (Figure 1).

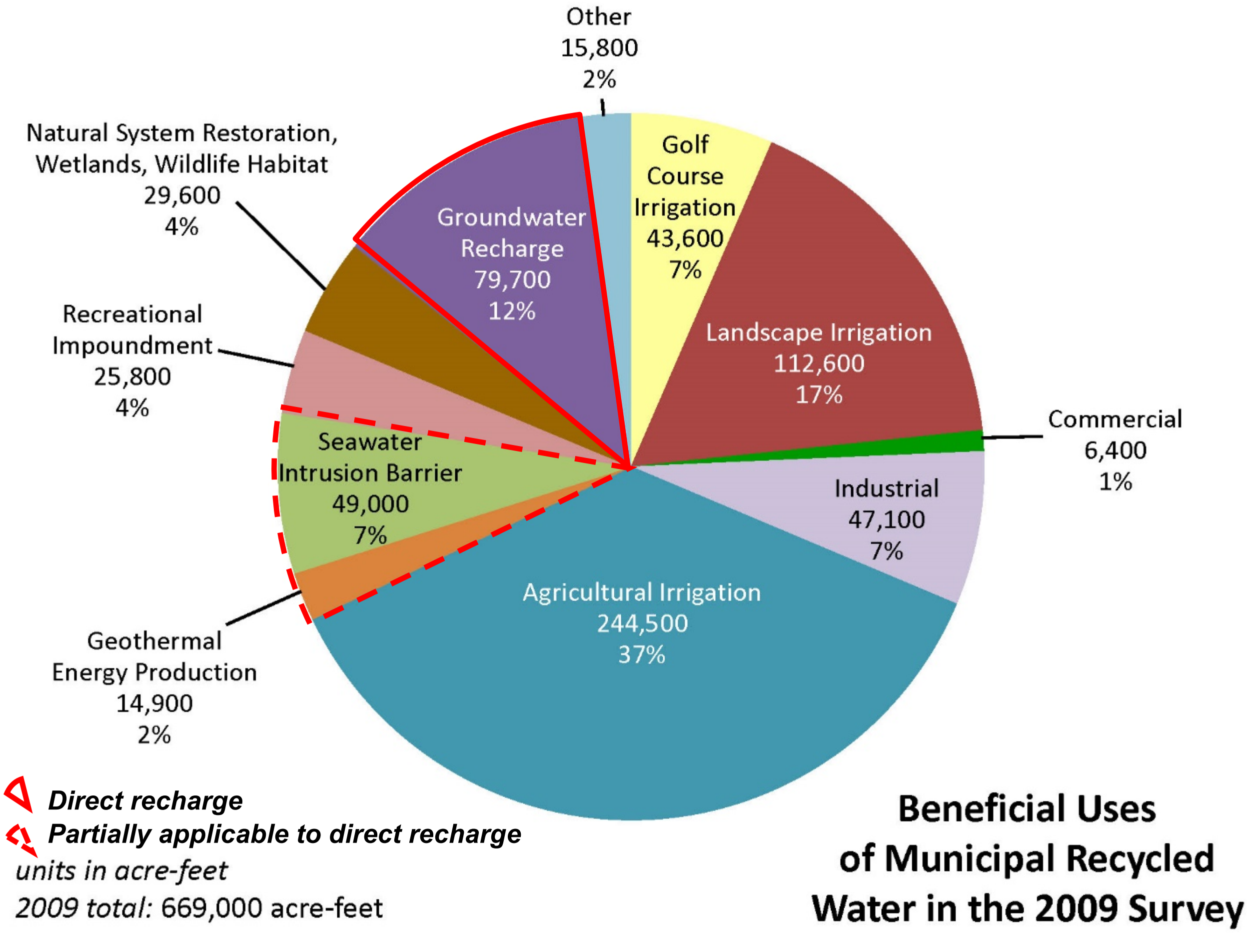


Figure C-R1: Beneficial Uses of Municipal Recycled Water in 2009 (reproduced from SWRCB 2012)

Direct groundwater recharge accounted for 79,700 acre-feet of the total beneficially reused and recycled water in 2009. In addition, portions of the recycled water used for seawater intrusion barrier (49,000 acre-feet) and geothermal energy production (14,900 acre-feet) directly increased recharge to groundwater basins. Several other categories of recycled water use in 2009, such as agricultural and landscape irrigation, likely provided in lieu recharge of groundwater by reducing groundwater pumping.

There are opportunities throughout the state for expanding and developing new recycled water projects that directly benefit groundwater resources.

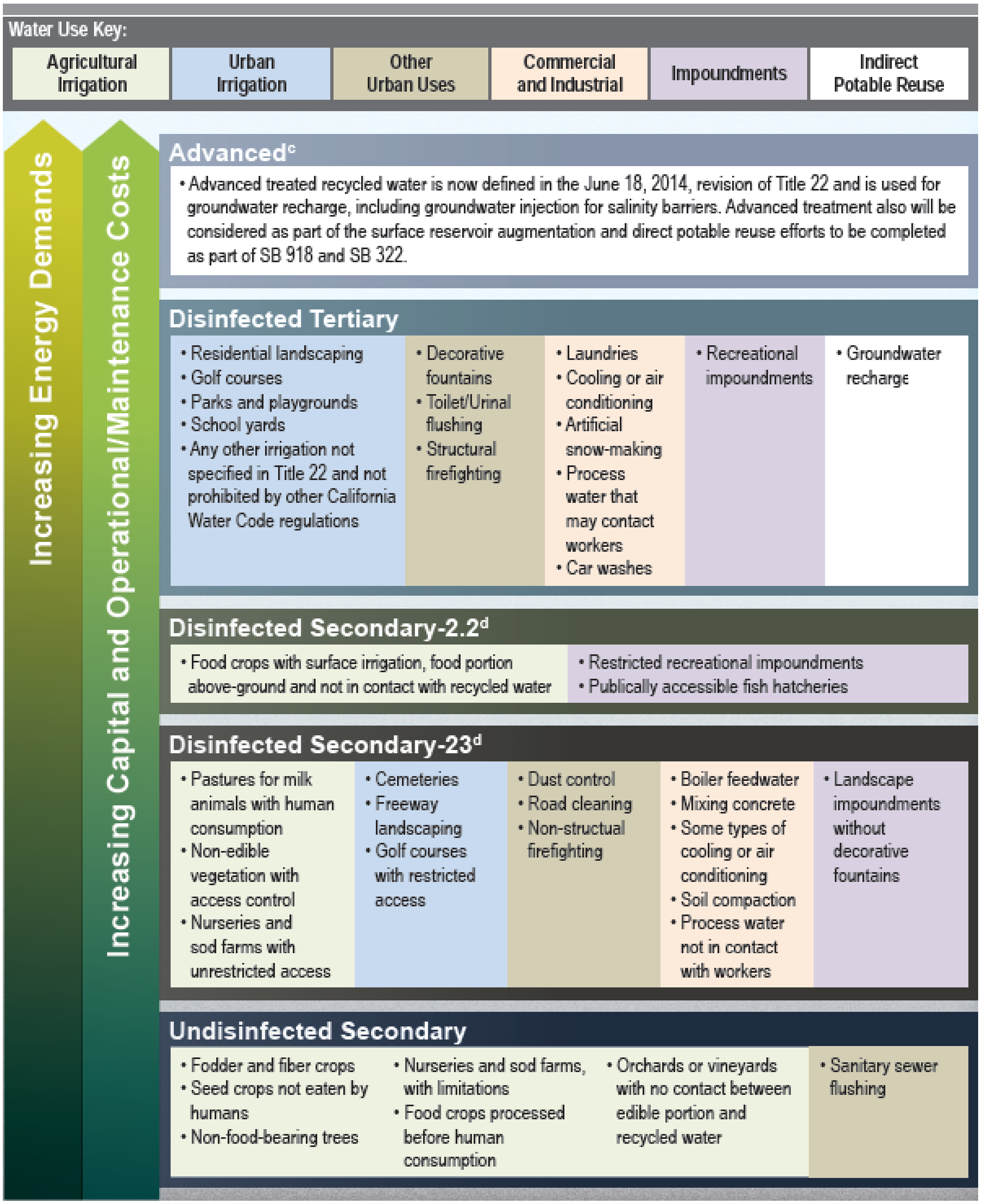
Considerations for All Recycled Water Projects

There are common issues that apply to using recycled water for groundwater replenishment in California. Each recycled water project is unique and thus, has specific issues that must be addressed. The following section describes these issues and provides references to additional resources.

Water Quality and Level of Treatment

The key component of a recycled water project including groundwater replenishment is determining the required treatment level of the recycled water for the proposed use. For example, direct recharge of groundwater with recycled water requires it to be either of disinfected tertiary (or advanced) treatment quality. In lieu recharge requires the recycled water quality to meet the standards of the replaced groundwater use. This is a critical component of the cost-benefit analysis to be done when assessing project viability and alternatives analysis.

California Code of Regulations Title 22, Division 4, Chapter 3, provides water recycling criteria (Figure 2). Recycled water is water that has undergone some level of treatment, but the term does not specify a certain level of treatment. Title 22 uses level of treatment and bacteriological water quality standards to define acceptable uses for recycled water. Levels of treatment range from water that has secondary wastewater treatment and is not disinfected to water treated by advanced technologies such as reverse osmosis and oxidation processes. The level of treatment required is dependent upon the intended use. Recycled water requires higher levels of treatment for uses that are more likely to come into direct contact with people or edible products. In many cases, secondary-treated recycled water can provide the source of water for the project.



a: Based on California Code of Regulations Title 22, Section 60001 et seq.

b: Uses for increasing levels of treatment also include all uses for lower treatment levels.

c: Wastewater treated with reverse osmosis and advanced oxidation processes.

d: Recycled water with a median concentration of total coliform bacteria not exceeding a most probable number of 2.2 or 23 per 100 milliliters (see California Code of Regulations, Title 22).

Figure C-R2: Title 22 Water Uses and Treatment Issues

Articles 5.1 and 5.2 of Title 22 contain the requirements for project sponsors and operators that deal specifically with groundwater replenishment reuse projects (GRRPs). Article 5.1 applies to replenishment by surface application, such as recharge ponds, while Article 5.2 applies to replenishment through subsurface applications, such as injection wells. The requirement for the level of treatment for surface application projects is that recycled water be filtered, disinfected, tertiary treated water. Title 22 also specifies limits on the Recycled Municipal Wastewater Contribution (RWC) to a replenishment project if tertiary recycled water is used for recharge. These limits specify the maximum fraction of the total replenishment from RWC, with the remaining replenishment from diluent water of a different source.

Articles 5.1 and 5.2 also provide monitoring and regulatory requirements for GRRPs. The articles recognize the unique nature of many projects by allowing latitude for RWQCBs to modify individual project requirements.

Water Available for Recycling

Many recycled water systems operate at full capacity during the peak irrigation season. When demand is lower during the winter months, the recycled water produced is commonly held in ponds or discharged, if customers have not been identified. Where extensive seasonal, non-potable irrigation use occurs, recycled water may be available for groundwater recharge during the off-season, if projects can be developed.

Another supply consideration is drought. Municipal wastewater effluent may decrease during droughts because less water is available for the water supply system or because of improvements in water conservation within the service district. Drought could also reduce the amount of storm or surface water available to blend in a tertiary spreading basin recharge project. Understanding the timing, rate, and volume of water available for recycling is very important for developing a direct or in lieu replenishment project.

Permit Changes

Most wastewater treatment plants operate under the requirements specified within National Pollutant Discharge Elimination System (NPDES) permits. The NPDES permit program was created in 1972 under the Clean Water Act to address point source water pollution by regulating the discharge of pollutants to waters of the United States. Implementation of the NPDES permit program in California was delegated to the State Water Board and the nine RWQCBs. The ownership and water rights of wastewater are addressed in Water Code Section 1210 through 1212; Section 1211 specifically states that approval from the SWRCB is required prior to making changes to the point of discharge, place of use, or purpose of use of wastewater.

Reducing the volume of wastewater discharged to a surface water body may potentially create another permitting issue. In some circumstances, downstream users may have rights to the use of discharged wastewater, which can prevent upstream communities from implementing recycling projects. Water rights assessment will be considered during changes to permits.

The reuse of treatment plant effluent may be subject to CEQA, NEPA, ESAs, and the Clean Water Act requirements. A comprehensive listing of the regulatory and permitting requirements is not provided; requirements will vary based on the type of project being implemented and its location.

Costs

The costs to implement recycled water projects vary based on the amount of water to be treated, treatment requirements, infrastructure needs, monitoring, project planning, permitting, and financing. As a result, project costs can vary widely. Given the variability of local conditions and their effect on treatment and distribution costs, the current estimated range of capital and operational costs of water recycling range from $300 to $1,300 per acre-feet of recycled water, but in some instances costs are above this range. Higher project costs are more likely to occur in urban areas and for projects that require new infrastructure and higher levels of treatment. Projects that can convey secondary treated effluent to agricultural users may be more cost effective than projects in an urban setting because less supplemental treatment may be needed. Overall, the actual cost of recycled water projects will depend on the quality of the wastewater, the level of treatment required, the proximity of potential users to the source of recycled water, and user costs to place recycled water to an end use.

Need for Replenishment Project

Recycled water can directly replenish groundwater basins either through surface applications (recharge ponds or spreading basins) or through subsurface applications (injection wells). If tertiary-treated recycled water is used for the surface application, a blend of surface or stormwater is required as described in the State Water Resources Control Board Division of Drinking Water's Recycled Water information (State Water Resources Control Board 2016).

Groundwater replenishment can be accomplished through in-lieu recharge when recycled water replaces source water supplied by groundwater. Golf course, general landscape, or agricultural irrigation supplied by groundwater can each be replaced with recycled water of a quality for uses identified in Title 22 (see Figure 2). In-lieu recharge projects involving agriculture will likely require conveyance infrastructure to connect secondary treated effluent with nearby agricultural areas.

It is also possible to couple recycled water projects with other projects that can assist with groundwater replenishment. For example, utilizing recycled water for urban irrigation reduces the demand for water from other sources such as imported or local surface water. These other water sources can then be made available to projects for in-lieu or direct recharge.

Conveyance

The method of replenishment, and the location of any associated replenishment project, will often require conveyance capacity to move water from the treatment facility to where it will be replenished. In some instances injection wells or spreading basins may be located near the wastewater treatment facility, but locating replenishment projects is typically based on soil types, hydrogeologic conditions, and areas of groundwater extraction. In-lieu recharge, particularly for agricultural irrigation, may require conveying the water over significant distances to reach agricultural areas outside of municipalities.

Regulatory Considerations

The current framework for overseeing municipal recycled water has been in place since the 1970s. The primary authority for regulating municipal recycled water is divided between the State Water Board and the nine RWQCBs. Multiple other state and local agencies are involved in the management and implementation of recycled water projects.

The DDW regulates public water systems and sets standards for wastewater reuse to protect public health by specifying sufficient treatment based on intended uses and human exposure. The treatment objective is to remove pathogens and other constituents, making the water clean and safe for its intended uses.

The State Water Board, through the RWQCBs, has the responsibility of permitting and providing ongoing oversight authority for water recycling projects. The NPDES permits incorporate applicable Title 22 water recycling criteria requirements and specify approved uses of recycled water and performance standards. The State Water Board also includes monitoring requirements for priority pollutants and chemicals of emerging concern. Additionally, RWQCBs have the authority to require additional limitations for the protection of beneficial uses, public health, and to prevent adverse effects on the fate and transport of contaminant plumes.

The State Water Board addressed the use of recycled water for groundwater recharge when it revised its *Policy for Water Quality Control for Recycled Water* (Recycled Water Policy) in 2013 (State Water Resources Control Board 2013). In this policy document, the State Water Board stated groundwater recharge projects utilizing recycled water must be reviewed on a project-by-project basis. Any approved groundwater recharge project would need to comply with either the regulations adopted by the DDW for groundwater recharge projects or Title 22, which defines requirements such as level of treatment, retention time, setback distance, source control, and monitoring. Since the Recycled Water Policy was last amended, the State Water Board adopted Title 22 regulations for groundwater recharge (Articles 5.1 and 5.2 described above).

In addition to the statewide agencies, local city and county officials also have a regulatory role affecting municipal recycled water projects. In some cases, the DDW can delegate responsibilities to local officials, if local project sponsors agree with the delegation.

Effect on Sustainable Management of the Groundwater Basin

As with other methods of making water available for replenishment, the effect of a recycled water project on the regional water budget must be analyzed and quantified. Recycling water is a sound management practice, but it may not have a positive effect on the groundwater budget unless it includes an associated replenishment project to move additional water into groundwater storage or reduce the volume of groundwater extraction. When including recycled water projects in a GSP, local GSAs must analyze and quantify the potential effects of proposed management actions on achieving the sustainability goal for the basin by ensuring the basin is operated within its sustainable yield. A technical evaluation must be performed to quantify the frequency, timing, and quantity of water made available by the project, and the resulting effect of these actions on annual groundwater budget and the longer-term sustainable yield of the basin. The method for making water available needs to be coupled with appropriate replenishment measures in order for the project to have a positive effect on the water budget and sustainability goal for the basin. Simply recycling treated municipal wastewater will not necessarily result in long-term replenishment of the basin or sustainable groundwater management as defined and required under the Sustainable Groundwater Management Act (California Water Code Section 10721).

Example Projects

Both direct groundwater recharge and replacing groundwater pumping with recycled water occur in California. Examples include:

- Los Angeles and Orange counties — Spreading basins using recycled water (tertiary quality) are used to recharge potable aquifers. Tertiary treated recycled water is injected along the coast at multiple locations to protect the basins from saltwater intrusion.
- Salinas Valley — Agricultural use of recycled water replaces groundwater use and reduces seawater intrusion. Direct injection of recycled water during winter months is being evaluated.
- Coachella Valley — Golf courses continue to replace groundwater irrigation with recycled water to help sustain the local groundwater basin.

References and Sources of Additional Information

California Code of Regulations, Title 22 Social Security, Division 4 Environmental Health, Chapter 3 Water Recycling.

National Research Council. 2012. *Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater.* Washington (DC): National Academies Press. 262 pp.

State Water Resources Control Board and Department of Water Resources. 2012. "Municipal Wastewater Recycling Survey." [Results of 2009 survey.] Viewed at: http://www.waterboards.ca.gov/water_issues/programs/grants_loans/water_recycling/munirec.shtml.

SWRCB, 2016, "Division of Drinking Water's Recycled Water Information" Viewed at: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/RecycledWater.shtml.

U.S. Environmental Protection Agency. 2012. *2012 Guidelines for Water Reuse.* EPA/600/R-12/618. Viewed at: http://nepis.epa.gov/adobe/pdf/p100fs7k.pdf.

Appendix C-D: Desalination Method Guidance

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Overview

This method guidance provides information and considerations for desalination as a water treatment method to make water available for groundwater replenishment. Desalination is one of the few options available to augment freshwater supplies to help meet a growing water demand. As with all water supply development alternatives, providing fresh water through desalination techniques depends on the challenges of financing, planning, designing, permitting, constructing, and operating desalination facilities. This method guidance provides an overview of these challenges and sources of additional information for GSAs considering desalination in their portfolio of water supplies for achieving groundwater sustainability.

Desalination can be used to reduce salinity from a variety of water sources to produce a water of lesser salinity than the source water. Source water for desalination can include surface water, groundwater, municipal wastewater, and industrial processor wastewater. Desalinated water can be used for potable uses, such as municipal drinking water, or non-potable applications, such as agricultural irrigation. There are water treatment facilities in California that desalinate seawater for coastal communities and brackish groundwater for inland water users. In this method guidance, a broad description of the common issues for desalination of water sources is described in general terms; additional information on desalination can be found in Volume 3, Chapter 10 of California Water Plan Update 2013.

Considerations for All Desalination Projects

While each desalination project is unique, there are common considerations for all desalination projects.

Source Water for Desalination

Saline sources that are suitable for a water supply development project can include water from the ocean, enclosed bays, inland surface water bodies, and brackish groundwater. Salinity levels and other water quality parameters can vary widely, based on water sources which are generally classified as either brackish water or seawater. There is no fixed delineation between “fresh,” “brackish,” or “sea” water. The California Water Plan uses a total dissolved solids (TDS) threshold of 1,000 mg/L, or 0.1 percent salinity to differentiate between fresh water and brackish water, and a TDS of 30,000 mg/L, or 3 percent salinity, to differentiate between brackish water and seawater. In this method guidance, *seawater* refers to water with general ocean water quality and a salinity level of at least 3 percent. *Brackish water* refers to water with a lesser salinity than seawater, but requires desalting for its intended beneficial uses.

Brackish water is most commonly associated with groundwater aquifers, inland surface water bodies, bays, and estuaries. Currently, brackish groundwater located inland from the ocean is the most common water source for desalination in California. Seawater can be extracted from wells drilled under or immediately adjacent to the ocean floor, which serves as a filter to reduce water treatment costs and effects on marine life.

Wastewater from municipal, institutional, industrial, agricultural, or other sources may require desalination before being used as a source of water for groundwater replenishment. Because wastewater is from a controlled source, its use for groundwater replenishment is classified as indirect reuse, which may include potable and non-potable beneficial uses after replenishment. See the method guidance on recycled water, Appendix C-R, for information on making treated municipal wastewater available for replenishment.

The source of raw water requiring desalting significantly influences the issues and challenges associated with water supply development projects. The planning, permitting, design, construction, and operation of inland desalination facilities can vary significantly from facilities along the coast, bay, or estuarine sources (California Department of Water Resources 2008). The environmental effects to the marine environment of extracting seawater from subsurface intakes can be significantly different from open-water intakes.

Need for Replenishment Project

Desalinated water can replenish groundwater via in-lieu or active recharge methods. Desalinated water may be used in-lieu of groundwater as a source for municipal, industrial, or agricultural water supply, or used for direct replenishment of groundwater either through surface applications, such as recharge ponds, or subsurface applications, such as injection wells.

Effects on Sustainable Management of the Groundwater Basin

In the context of sustainable groundwater management, desalination projects should consider the potential effects of proposed management actions on achieving the sustainability goal for the basin by ensuring the basin is operated within its sustainable yield. A technical evaluation to quantify the frequency, timing, and quantity of desalinated water made available by the project, the resulting effect of these actions on annual groundwater budgets, and the long-term sustainable yield of the basin must be performed. Desalination needs to be coupled with appropriate replenishment measures in order for the project to have a positive effect on the water budget and sustainability goal for the basin. Desalination alone will not necessarily result in long-term replenishment of the basin or sustainable groundwater management as defined and required under the Sustainable Groundwater Management Act (California Water Code Section 10721).

The extraction and desalination of brackish groundwater may provide an additional water source for a region, but the effect on the regional groundwater budget may reduce the volume of water stored in aquifers. The effect of a desalination project on the regional water budget should be carefully analyzed and quantified if new desalination projects are proposed to achieve sustainability goals.

Desalination Challenges

There are numerous challenges to financing, planning, designing, permitting, constructing, and operating desalination facilities in California. Many of these challenges are the reason why reported production of desalinated water in 2010 was approximately 80,000 acre-feet, despite a much higher level of supply potential and despite water being relatively scarce in many regions of California. The following sections provide an overview of some of the challenges associated with desalination.

Permitting and Regulatory

There can be over 20 federal, State, and local agencies that have some regulatory or permitting authority over desalination projects. Government regulations and laws affecting desalination are evolving with the development of new projects and technologies. **Table C-D*1*** provides an overview of the different agencies and their role in the permitting or regulatory process. Not every agency will be involved with every desalination project because the specific characteristics of each project can vary.

Table C-D1. Regulatory Agencies and Roles for Municipal Desalination Projects

Organization	Role
National Marine Fisheries Service	Provides Endangered Species Act (ESA) Section 7 consultation to address potential incidental take of federally listed species.
National Marine Sanctuaries	Issues Research Permit or Authorization, Education Permit, or Authorization Permit.
	Reviews other State and federal permits (including U.S. Army Corps of Engineers, RWQCB 401, and NPDES permits) with activities/discharges into waters and wetlands.
U.S. Army Corps of Engineers (USACE)	Issues Clean Water Act Section 404 permit for discharge of dredge/fill into waters of the United States, including wetlands.
	Issues Rivers and Harbor Section 10 permit for activities, including the placement of structures, affecting navigable waters.
	Issues permit for survey activities, such as core sampling, seismic exploratory operations, soil surveys, sampling, and historic resources surveys, under Nationwide Permit No. 6, Survey Activities.
	Issues permit for activities related to the construction or modification of outfall structures and associated intake structures where the effluent is authorized by NPDES under Nationwide Permit No. 7, Outfall Structures and Associated Intake Structures.
U.S. Coast Guard	Provides consultation on Coastal Commission Coastal Development Permit.
	Provides consultation on USACE Section 10 Permit.
U.S. Environmental Protection Agency	Issues permits for injection wells used for brine disposal by deep well injection.
U.S. Fish and Wildlife Service	Provides Endangered Species Act (ESA) Section 7 consultation to address potential incidental take of federally listed species.
	Provides comments to prevent loss of and damage to wildlife resources under the Fish and Wildlife Coordination Act.
Other Entities	Specific permits or consultations may be required on a project-specific basis.
Federal Energy Regulatory Commission	

Tribes NOAA	
STATE	
State Water Resources Control Board, Regional Water Quality Control Board	NPDES, General Permit For Storm Water Discharges Associated With Construction Activity. NPDES Permit in accordance with the Clean Water Act (CWA), Section 402. Water Quality Certification in accordance with CWA Section 401. Waste Discharge Requirements (WDR) per Porter-Cologne Water Quality Control Act. Under the 2015 amendments to the California Ocean Plan, provides determinations required by Water Code section 13142.5, subdivision (b) for the evaluations of the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life at new or expanded desalination facilities.

Organization	Role
California State Lands Commission	Issues Land Use Lease (Right-of-Way permit) for right-of-way across State lands.
California Department of Fish and Wildlife (DFW)	Issues Incidental Take Permits where a State-listed candidate, threatened, or endangered species under California ESA may be present in the project area and a State agency is acting as lead agency for CEQA compliance.
California Coastal Commission (CCC)	Issues a Coastal Development Permit within the Coastal Zone, excluding areas where local jurisdictions have approved Local Coastal Plans in place.
California Department of Public Health (CDPH)	Issues a permit to operate a public water system.
California Department of Parks & Recreation Office of Historic Preservation	Consults with project applicant, appropriate land management agencies, and others regarding activities potentially affecting cultural resources, under Section 106 of the National Historic Preservation Act.
California Department of Transportation	Issues Encroachment permits for State roads and highways.
Other Entities	Specific permits or consultations may be required on a project-specific basis.

California Independent System Operator (ISO) California Energy Commission	
REGIONAL AND LOCAL	
Local Lead Agency	Approves CEQA documentation
County and City Departments, including but not limited to Planning, Transportation, Public Works, Environmental Health, Building, and various utilities (electrical, gas, solid waste , wastewater, water, and stormwater)	Issues use permits. Issue Coastal Development Permit/Exemption for development within the Coastal Zone where City or County has jurisdiction through Local Coastal Program Consistency. Issues encroachment permits for activities within rights-of-way. Issues grading permits; issue electrical permits; issue erosion control permits; issues building permits; issue right-of-way permits. Issues haul route permits; issue connection permits. Approves hazardous materials management plan. Issues well permits, where jurisdiction is granted.
Air Pollution Control District	Issues permit to construct; issues permit to operate.
Other Entities	Specific permits or consultations may be required on a project-specific basis.
Adjudicated basin watermaster Groundwater management	
CEQA = California Environmental Quality Act, ESA = Endangered Species Act, NOAA = National Oceanic and Atmospheric Administration, NPDES = National Pollutant Discharge Elimination System, RWQCB = Regional Water Quality Control Board.	

Energy Use and Sources

Energy use is a significant factor affecting the feasibility of water desalination projects, as a result of operating costs and environmental effects of energy generation. Each of the elements in the desalination system shown in **Error! Reference source not found.** requires energy use. The greatest amount of energy in the treatment process is the act of removing salt ions from the water. Given similar operating conditions and treatment plant parameters, brackish water desalination is usually less energy intensive, and hence less costly, than seawater desalination. Several summary reports on desalination and energy intensity of water supply and treatment systems are provided in the references with published data on the energy intensity of desalination processes.

Because of the energy requirements for desalination and the SB 32 requirement to reduce greenhouse gas emissions 40 percent below 1990 levels by 2030 (California Senate Bill 32 2015), it is especially important to look at the sources of power used to operate plants. Although there has been an emphasis on expanding reliance on sustainable/renewable energy sources within California, fossil-fuel-based power plants still provide about 62 percent of total in-state electricity generation. The use of these power plants for desalination raises concerns of air pollution, including greenhouse gases (GHGs). Coupling water supply development projects, from desalination facilities to renewable non-GHG generating power production systems, provides resiliency, redundancy, and reliability for meeting California's sustainability goals.

Financial Challenges

While technological improvements have reduced the cost of desalination, seawater desalination remains one of the most expensive water supply options. Desalination costs are especially influenced by the type and salinity of source water, the available concentrate disposal options, the proximity to potable water distribution systems, and the availability and cost of power. To a lesser extent, the cost of desalination treatment is also influenced by the treatment capacity. For example, the unit cost of construction of a 50 million gallon per day (MGD) membrane desalination plant will be half the cost of a 1 MGD plant. Combined capital and operating costs of existing groundwater desalters in Southern California range from $600 to $3,000 per acre-foot. Recent estimates of proposed large-scale seawater desalination projects in California range from about $1,600 to $3,000 per acre-foot (DWR, July 2016).

Concentrate Management

The byproduct from the various separation processes used in desalination results in a concentrated solution of salt ions defined as *concentrate*. The terms *reject*, *brine*, and *wastewater* are also commonly used to refer to the concentrate generated and managed at desalination facilities. Depending on the source water, desalting technology used, and the process configurations employed, the concentrate will be of a specific character that must be properly managed. Brine discharges from desalination facilities are regulated by the State Water Resources Control Board through issuance of a National Pollutant Discharge Elimination System (NPDES) permit.

The discharge and disposal of brine is a challenge for desalination facilities when the salinity of the brine is significantly higher than the receiving water. These adverse effects can be reduced, but not entirely eliminated, by inducing rapid mixing of the brine with receiving waters.

Land application of brine can be achieved with percolation ponds or by applying it to vegetation when the vegetation can tolerate the salinity. Typically, land application of brines are limited to smaller volumes of concentrates and are often limited by availability of land or dilution water (Mickley 2003). Percolation of saline water coming from brine applied to land can be prevented through proper design of evaporation ponds and landfills.

Brine from brackish water desalination systems in California is frequently discharged to municipal wastewater collection systems for treatment. This is acceptable where the wastewater treatment system capacity is adequate to treat the brine. The brine may also be blended with treated municipal wastewater as long as the waste discharge requirements are met under the NPDES permit.

Environmental Concerns

Several environmental concerns discussed in previous sections include the effects of ocean intakes on marine wildlife, concentrate management, and the potential for increases in GHG emissions resulting from the high energy use of desalination facilities using conventional electric power. Other environmental concerns include the effects of new facilities construction, particularly in coastal areas, on the environment.

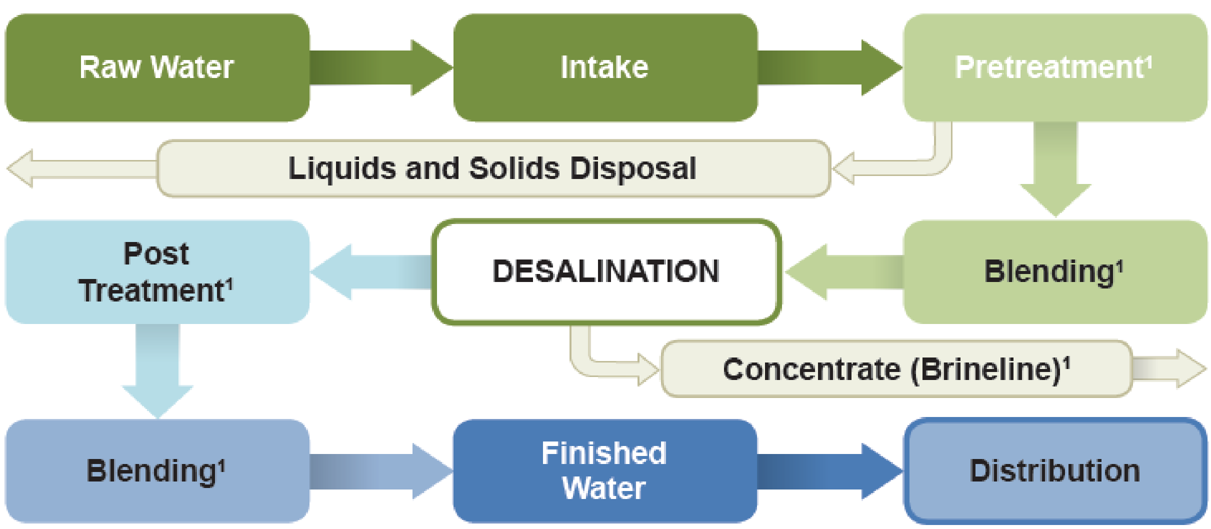
Subsurface Extraction

Concerns related to subsurface extraction include potential groundwater overdraft and inland intrusion of brackish and seawater. Groundwater extraction near the coast typically exacerbates seawater intrusion by reducing the overlying pressure of freshwater, allowing seawater to flow further inland, which can degrade water quality in existing aquifers. The overall effect of subsurface extraction on a basin's groundwater budget must be considered and quantified to ensure there is a net increase in groundwater replenishment with the project.

Elements of Desalination Projects

A general schematic of a desalination system is shown as **Error! Reference source not found.**. Some systems may omit one or more of these elements, arrange the elements in a different sequence, or combine various elements into a single component.

Figure C-D1. General Desalination System Schematic



[1] May not occur at specific desalination facilities

All desalination systems need a source of raw water, or *feed water*. Raw water considerations will be different for wastewater and subsurface and surface sources, but both include water quality and sustainability issues. The type of intake system used is dependent on the raw water source, with different intakes for subsurface sources and surface sources. Open, screened intakes for desalination systems using seawater as a source can be a significant area for concern because of the potential for impingement and entrainment of marine organisms.

Once raw water has been brought into the desalination system, it may undergo some form of pretreatment prior to the desalination process. Desalination technologies, especially reverse osmosis (RO) facilities, require feed-water to meet minimum water quality thresholds to avoid damage, corrosion, membrane fouling, impaired performance, or excessive maintenance to the desalination equipment. Mechanical screening is the first form of pretreatment for open intakes, while sediments in the ground can be a form of pretreatment by filtering raw water for subsurface intakes. Blending may be another form of pretreatment, to improve the desalination operations, or it may occur after desalination to improve the finished water.

Desalination Methods

A wide range of technologies, methods, and processes can be used to achieve a desired level of salt removal in water. For additional information on desalting technologies and other aspects of treatment processes, start by reviewing “Overview of Types of Desalination Technologies” in Chapter 10 Desalination (Brackish and Sea Water), Volume 3 – Resource Management Strategies, California Water Plan Update 2013. Another valuable reference is *Desalination: A National Perspective* (https://www.nap.edu/catalog/12184/desalination-a-national-perspective).

Desalination Planning Process

Many factors should be considered before deciding whether to implement a water desalination project. Drawing on the work of the California Water Desalination Task Force convened in 2003, DWR published the *California Desalination Planning Handbook* (California Department of Water Resources 2008). This handbook is a valuable resource for project proponents and communities. It provides a planning framework for developing, where appropriate, economically and environmentally acceptable desalination facilities in California. The planning process outlined in the handbook is intended to identify and address siting, regulatory, technical, environmental, and other issues, which should be considered when determining whether and how to proceed with a desalination project.

DWR compiled additional publications and information on desalination at:

http://www.water.ca.gov/desalination/publications.cfm

Existing Desalination Projects in California

There are several existing municipal desalination projects in operation in California. **TableC-D*2*** provides examples of projects successfully planned, constructed, and in operation.

TableC-D2: Existing Operational Desalination Projects

Facility	Capacity (MGD)	Operator	Operations Started	Source Water
Newark Desalination Facility	10	Alameda County Water District	2003; expanded 2010	Brackish groundwater
Chino 1 Desalter	14	Inland Empire Utilities Agency	2001; expanded 2005	Brackish groundwater
Chino 2 Desalter	10.6	Inland Empire Utilities Agency	2006; expanded 2012	Brackish groundwater
Carlsbad Desalination Plant	50	Poseidon Water	2015	Seawater

Additionally, DWR compiled information on desalination facilities, both in operation and in different stages of the planning process, for California Water Plan Update 2013. Table C-D3 is a summary of existing and possible future municipal water desalination projects.

Table C-D3: Summary of California Desalting, 2013

	In Operation			In Design & Construction		Proposed	
General Source Water Designation	No. of Plants	2010 Production	Annual Capacity	No. of Plants	Annual Capacity	No. of Plants	Annual Capacity
Brackish groundwater	23	79,812	139,627	3	9,050	17	74,629
Brackish surface water	0	0	0	0	0	1	22,403
Ocean water	3	130	562	1	56,007	15	381,791
Total	**26**	**79,942**	**140,189**	**4**	**65,057**	**33**	**478,823**

Note: Production and capacity are in acre-feet per year.

References and Sources of Additional Information

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Appendix C-WT: Water Transfers Method Guidance

Table of Contents

Introduction

Water transfers offer a means of supplementing water supplies, including replenishing overdrafted groundwater reservoirs, or for direct use in lieu of groundwater. Water transfers involve the acquisition of water from a willing party (seller), with legal entitlement to the water, to be used at another location or for a different purpose. Legal entitlements to the water include a license, permit, right, or contract. The entitlement must also allow for the transfer of water. Usually, transfer of water involves compensation to the seller, either monetary or through exchange of water, that is repaid at a later time, but generally not at a 1:1 exchange (Fresno Bee, 2010, Fresno Bee, 2014).

There are a number of processes and complexities in transferring water from the seller to the buyer. Each transfer is unique and must be evaluated on a case-by-case basis. This chapter presents an overview of the process and considerations to execute a successful transfer. Section 4 of this appendix provides references with the details of the water transfer process.

History, Trends, and Future of Water Markets in California

Water markets have operated in California since at least 1977, when the U.S. Bureau of Reclamation (Reclamation) operated a drought water bank. Periodic droughts, along with regulatory actions during the last 25 years, have resulted in reduced water deliveries to State Water Project (SWP) and Central Valley Project (CVP) contractors. These regulatory actions include the Central Valley Project Improvement Act (CVPIA), the application of the Endangered Species Act (ESA) to the operations of the CVP and the SWP, and the enforcement of California's water allocations to the Colorado River. The almost perpetual reduction in water deliveries to these contractors, in all but the wettest years, has created the demand for water transfers.

Dry-year water purchase programs and drought water banks operated by DWR spurred the emergence and further development of water markets (Lund et al.,1992) such that by the drought beginning in 2009, water markets had matured to the point that there was no longer a need for a government broker to complete water transfer transactions. Most of the water that was transferred across the Delta in 2009 occurred outside of the DWR-operated drought water bank (74,051 acre-feet vs. 200,185 acre-feet).

Figure C-WT1. Water Transfer Process Flowchart – Agency Jurisdiction

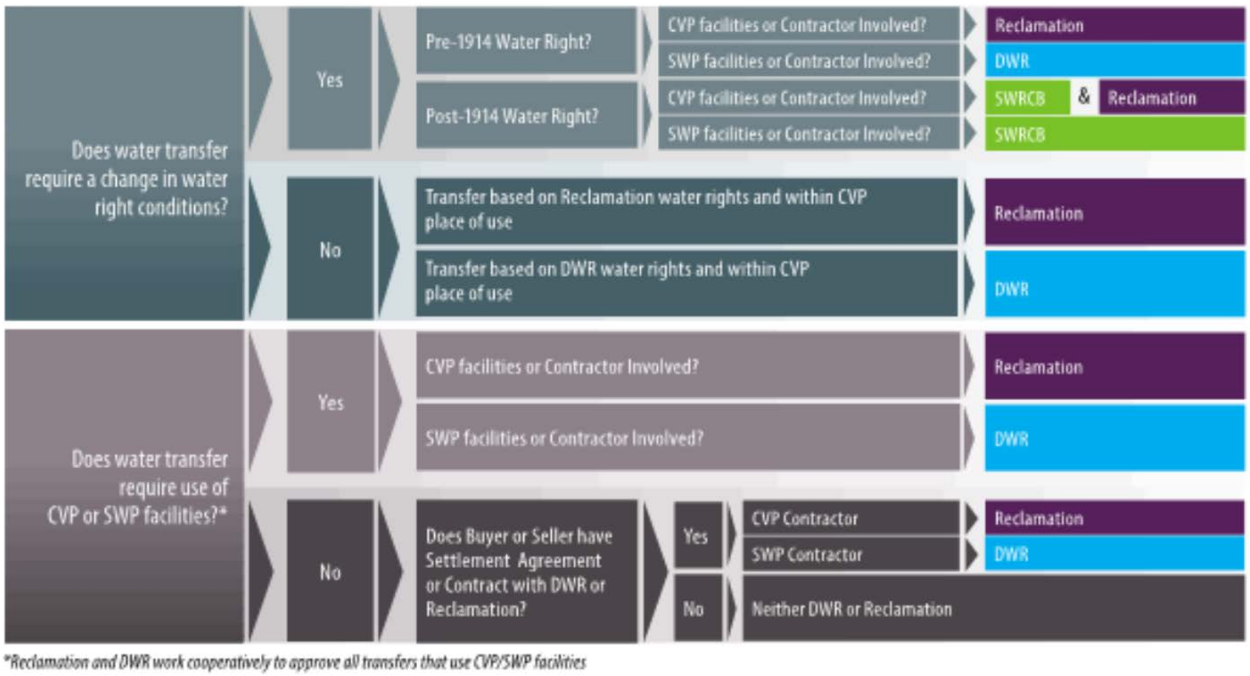


Figure C-WT2. Water Transfer Process Flowchart – Agency Requirements

AGENCY	DWR	Reclamation	SWRCB
How to start agency process?	• Contact DWR with transfer proposal and request conveyance through SWP • Agree to cost reimbursement	• Send letter of request for transfer with information on seller, buyer, type, amount, and timing of transfer • Reclamation sends letter back with cost reimbursement requirements • Agencies agree to move forward	• File a petition for Change with SWRCB, Temporary Urgency Change (urgent need), Temporary Change (WC § 1725) or long-term (WC § 1735) • Applicable to post 1914 water rights
What technical information is required in submittal package?	Information identified in Water Transfer White Paper for specific type of transfer	• Information listed in • CVPIA Criteria Checklist for a complete written Transfer Proposal • Water Transfer Technical Information (crop shifting/ cropland idling and groundwater substitution)	Information listed on SWRCB Petition for Change form and in Environmental Information form provided on SWRCB website
What regulatory compliance is required?	CEQA, ESA, CESA, SWRCB approval, as applicable, and local and regional requirements depending on the location of the proposed transfer	NEPA and ESA	SWRCB approval of Petition for Change for all transfers of post 1914 water rights
What is acceptance of transfer proposals based on?	• Complete proposal submittal • DWR determination of new water made available • Availability of SWP capacity and determination that transfer will not resulit in impacts to SWP operations • DWR findings under WC § 1810(d) • Compliance with CEQA and any other applicable regulatory requirements	• Complete Submittal Package • Determination of new water and Project operation considerations • CVPIA section 3405(a) - No adverse impacts on CVP contractors, water supply or operations, fish and wildlife obligations, and groundwater conditions in the transferor area • NEPA	Determination that transfer will not result in injury to other legal users of water, or unreasonable impacts to fish, wildlife or other instream beneficial uses

The primary source of water for water transfers has been agricultural water suppliers (Hanak et al, 2012). Reliable sources of water for transfer are a number of water rights holders in the Sacramento River and San Joaquin River basins that have entered into settlement agreements with DWR or Reclamation, which provides these suppliers with a high level of water supply reliability. Additionally, some senior water rights holders (agricultural water supply) in the Sacramento, San Joaquin, and Imperial valleys have been reliable partners for water transfers. Parties with the most senior water rights are the last to be curtailed in the event of a drought.

A major shift in Central Valley agricultural production, from annual crops to permanent crops, is changing the economics of water transfers. High value permanent crops, such as nut crops, are driving the drought pricing of open-market water to levels not previously seen, as demonstrated by the results of water auctions in response to the current drought. Bids as high as $2,200 per acre-foot were received from farmers (one order of magnitude higher than historically typical prices) (The Times Herald, 2014). Beyond increasing demand for open-market water, the shift to permanent crops has reduced fallowing as a drought management tool. In summary, the result of environmental regulations has created perpetual shortages for some CVP contractors, and these contractors are frequent buyers of water in all but the wettest years.

It is likely that the Sustainable Groundwater Management Act (SGMA) will have a major impact on the water market landscape. In response to SGMA, groundwater management agencies may manage overdraft conditions by (1) importing water (on an intermittent or continuous basis) and replenishing the aquifer or using the imported water in lieu of groundwater, (2) reallocating the groundwater supplies to sustainable levels, or (3) a combination of importation and reallocation. Surface and groundwater supplies can potentially be coordinated to maximize use of surface supplies during wet periods, and to replenish aquifers while using groundwater during low availability of surface water (conjunctive management). Many basins have practiced conjunctive use, but in severely over-drafted basins, intermittent importation (short-term transfers) of water may not be sufficient to attain sustainability, and additional measures will be needed. In more severe overdraft conditions where a conjunctive approach alone cannot achieve sustainability, long-term or permanent water transfers, which provides annual allocations, will need to be considered in the absence of other alternatives to address sustainability. A long-term transfer can provide reliable annual supplies to address in part or in-whole the water supply deficit.

Water transfers originating from upstream of the Delta are an unlikely source, in situations in which a continuous (annual) water supply augmentation has been identified, as a management tool to achieve sustainability in a groundwater basin. This is because water transfers from upstream to downstream of the Delta have a high risk that water purchased may not be able to be delivered because of insufficient conveyance capacity. Owing to this risk, cross-Delta transfers are generally temporary, one year or less, contracts and for which risk of unavailable conveyance must be managed. The Yuba Accord is an exemption, but it was negotiated prior to the implementation of transfer restrictions on CVP and SWP operations. When California WaterFix becomes operational, the risk is likely to be reduced or eliminated. Water transfers originating in the Imperial Valley have reliable delivery, and are therefore generally long-term transfers (multiple years).

Although compliance with SGMA is in its early stages, creative market-based approaches are emerging where basin needs will be addressed at the local level. The local approach may be the most sustainable and economical method of addressing water supply needs, because the importation of water supplies to address large and long-term deficits may not be feasible or reliable.

Considerations for all Transfers

At a broad level, there are two types of considerations with regard to water transfers in sustainable groundwater management. First of these is the logistics of managing water transfers. The second relates to the process for acquiring the transfer water. With regard to the latter, there are processes that are specific to the type of transfer (e.g. crop idling, groundwater substitution, etc.) and there are considerations that are common regardless of the method by which water is made available for transfer.

Logistical Considerations

Before a GSA pursues specific water transfer project(s) there are five elements that need to be considered:

1. The role of water transfers in achieving sustainability.
2. Monitoring and accounting for water transfers (intra- and inter-basin).
3. Availability of conveyance to import water to the basin and to distribute within the basin.
4. Disposition of imported and surplus water (how will these waters be managed).
5. Risk assessment and management.

Role of Water Transfers — Planning

The five elements relate to upfront planning and should be addressed in an integrated basin management plan which, if logistics permit, should integrate surface and groundwater supplies in managing basin demand. The basin management plan should be coupled to the integrated regional water management plan (IRWMP). The IRWMP will identify potential regional partners and the availability of conveyance infrastructure to import water.

The groundwater sustainability plan (GSP) should include the role that water transfers will play in achieving sustainability, both through the importation of water (intra-basin transfers) and through the re-allocation of supplies within the basin (inter-basin transfers). If the importation of water is feasible, the GSP must consider the mix of conjunctive use, which relies on intermittent intra-basin transfers, and permanent transfers which will provide continuous supplies and is intended to address supply deficits that are not feasibly met by conjunctive use alone.

Monitoring and Accounting

A monitoring and accounting system needs to be established for the purpose of managing water transfers. Once the water is delivered to the basin, accounting needs to be provided to track and document the disposition of the transfer water, including amount of water imported, amount of water used in lieu of groundwater supplies and by whom, amount of recharge, and credits to the appropriate parties for recharge. An accounting system analogous to a bank checking account has been suggested, where each basin water user is issued an account and withdrawals (pumping or extraction) and deposits (replenishment) are tracked for each user relative to allocations. This is consistent with how groundwater banking is already practiced in Kern County and other regions.

Conveyance

Conveyance needs to be considered at two levels: (1) from one hydrologic basin to another (e.g., imported water, inter-basin transfer), more often using large-scale canals owned by other parties, and (2) in-basin distribution of water to distribute imported water to in-basin users for in-lieu of groundwater use, and to deliver imported water to recharge centers, including spreading grounds or injection wells. The availability of conveyance will influence the extent that water transfers will be used to manage sustainability of the basin.

Inter-basin transfers are facilitated by the access to conveyance facilities of other public entities. The California Water Code (Section 1810) allows any water transfer proponent access to up to 70 percent of any unused conveyance capacity of any publically owned conveyance system. The access to unused conveyance capacity is subject to fair compensation for the use of the conveyance and contingent that certain conditions about impacts are met (California Water Code 1810(d)).

In an inter-basin water transfer, direct conveyance of water from the seller to buyer is the most common, but not only, means of implementing a transfer. A variety of exchanges have been employed by creative parties to transfers, with such arrangements potentially requiring involvement of multiple third parties (Fresno Bee, 2014).

Transfers from upstream to downstream of the Delta will require the use of either CVP or SWP conveyance facilities. More than likely these transfers will require the use of DWR's facilities over Reclamation's, because DWR has more capacity (pumping and canal conveyance) than Reclamation. In most years, and during the active summer pumping period, Reclamation's limited capacity is occupied conveying CVP contract supplies.

In the course of conveying water from the seller's point of diversion to the buyer's point of diversion, there is potential for the loss of water resulting from seepage, evaporation, and other means. These losses need to be accounted for, especially if they are significant. Accounting for these losses is done by reducing the diversions by the amount lost at the point where the buyer takes possession of the transfer water. If these losses are not accounted for, the buyer is taking more water than actually made available by the transfer and will injure other water users and the environment.

An operational consideration for transfers conveyed across the Delta is carriage water. Carriage water is the extra amount of Delta outflow required as a result of an increase in pumping to maintain the Delta water quality standards contained in State Water Resources Control Board (SWRCB) D-1641. DWR and Reclamation estimate carriage water based on annual hydrology. Carriage water losses are applied to the quantity of transfer water made available above the Delta. This reduces the quantity of water that is actually exported from the Delta. The amount of carriage water required to export transfer water can vary significantly from year to year. In the past, the carriage water requirement has ranged from 20 percent to 35 percent, depending on that year's specific conditions.

Replenishment Methods

Regardless of whether water imported to the basin is used (1) in lieu of groundwater supplies, (2) to recharge the basin, or (3) a combination of in lieu and recharge, each of these processes will improve water levels in the basin.

The disposition of the imported water in the basin is dictated by the relationship of the rate, volume, and timing of the import relative to in-basin use, and demand and ability to distribute the imported water throughout the basin. Ideally, it is most efficient to use the imported water in lieu of groundwater supplies. To the extent that imported water can be matched with in-basin demand and ability to distribute (in lieu use) the more efficient the management of the imported water will be. This can be best achieved if the basin is managed as a unit, as opposed to individual extractors (pumpers) acting independently without coordination.

When the rate, amount, and timing of water imported to the basin exceeds basin demand, or the ability to distribute to users, then this excess water will be used to replenish the basin. Recharge of the basin can be achieved through spreading grounds, or artificially through injection wells.

Risk Identification and Management

The primary risks to transferring water into the basin are with the conveyance of the transfer water. To successfully transfer water, the excess conveyance capacity has to match or exceed the rate and timing that the transfer water is made available. The level of risk can be minimized by evaluating the historic records to assess the frequency and circumstances upon which conveyance would not have been available over the time period that conveyance will be needed. Understanding the frequency and factors that limit conveyance capacity will allow the users to assess the risk and manage accordingly.

One particular conveyance system for which risk is well understood is in transferring water across the Delta. These transfers will require the use of CVP or SWP facilities. The risks of transferring water using the CVP or SWP facilities are discussed in the Water Transfer White Paper (Section 1.2). In general, the biological opinions for the coordinated operations of the CVP and SWP have limited export operations in winter and spring, such that exports are maximized in the summer period. At the same time, the biological opinions restrict water transfers to July through September. Given that project water has conveyance priority, there is often limited, to no, conveyance capacity available for water transfers conveyance. This is why those looking to enter into long-term transfer agreements with the expectation of annual water allocations would probably not look to transfers that require Delta facilities to complete the transfer.

Additional factors that may present risks to completing a transfer are the regulatory approvals and potential oppositions to the transfer. Risks can be reduced by consulting those agencies with approval authority early in the process to identify and address potential pitfalls. Figure C-WT1 provides a flowchart process to identify which agencies have approval authority for the transfer. Additionally, the transfer proponents can reach out to other water users with potential to be impacted by the transfer to inform and address concerns. The complexity and potential opposition to the transfer is proportional to the distance of the water conveyance. As a result, it is best to seek sources of transfer water nearby and to form long-term relationships.

Water Transfer Approval Process

Regardless of how water is made available for transfer, there are three broad certain commonalities in securing approval for a water transfer. The common issues involved are (1) regulatory approvals, (2) environmental review, and (3) consideration of impacts (to other water users and to the instream biological resources) from the transfer. Two factors drive the direction and extent of regulatory and environmental review: (1) the type of entitlement (type of water right or contract), and (2) the term of the transfer. Only appropriative water rights are transferable. Thus, riparian rights are not. A wrinkle in the generalization that all appropriative water rights are transferable is whether the water right is subject to adjudication. If so, it is best to seek the assistance of a water rights attorney to determine what is allowed under the decree. There may also be a need to petition the court to seek permission to allow the transfer.

Regulatory Process

Figures C-WT1 and C-WT2 (flowchart) guide water transfer proponents through the regulatory process, showing which government agency has approval authority, and the process the regulatory agencies will use to make a determination. Appropriative water rights issued after 1914 are subject to the permitting process of the SWRCB. Appropriative water rights established prior to 1914 are not subject to the permitting process of the SWRCB. A water rights permit establishes the point of diversion, the place of use, and the purpose of use, among other things. Water transfers will require modifying at least one of these conditions. The process to transfer water under a post-1914 appropriative water right starts with a petition to the SWRCB to change the permit condition(s). The SWRCB Water Rights Petition website provides additional guidance on navigating the regulatory process.

The transferability of contract water depends on the limitations that the contract may place on transferring contract water. The CVP allows for transfers within and outside of the CVP, whereas SWP contract only allows transfer only within the SWP (between SWP contractors). Guidance for executing a transfer with CVP contract water can be found on Reclamation's water transfer website and guidance document. Article 56 of the State Water Contracts specifies the process for water transfers within the SWP.

Reclamation and DWR have oversight of a transfer that requires the use of either federal or State facilities to complete the transfer, regardless of the status of the appropriative water right with respect to 1914. These types of transfers will require a letter or conveyance agreement from the respective agency to allow access to these facilities. The Water Transfers White Paper outlines the information that these two agencies will require to develop the agreements that allow access to their facilities, and for DWR to make findings pursuant to California Water Code Section 1810(d).

Water transfers could also potentially impact the requirements of ESAs and the Clean Water Act. A comprehensive listing of the regulatory and permitting requirements is not provided; requirements will vary based on the type of project being implemented and its location

Environmental Review

The term of the proposed transfer (temporary, long-term, or permanent) and whether the appropriative water right is pre- or post-1914 will guide the level of environmental review. Water transfers that are 1 year or less, and for which the appropriative water right is post-1914, are exempt from the requirements of the California Environmental Quality Act (CEQA). But, the transfer must not result in an unreasonable effect on fish, wildlife, or other instream beneficial uses. If the transfer is long-term (1 year or more) the transfer requires compliance with CEQA. All water transfers for which the appropriative water right is pre-1914 will require compliance with CEQA regardless of the term and if one of the parties (buyer, seller, or conveyance facilitator) is a public agency. Water transfers that will use CVP facilities will need to comply with the National Environmental Policy Act regardless of the term or type of water right involved. ESA compliance applies to all transfer situations, if a listed species can be impacted by the transfer.

Impacts of Water Transfers

Common to all transfers, regardless of the term or water right status, is that no transfer should result in injury to other water users and no unreasonable affect to the instream biological resources. This is referred to as the “no injury” rule. The SWRCB will make these determinations in the process of evaluating petitions for permit changes if the transfer is subject to the permitting authority of the SWRCB. If the transfer requires the use of public facilities, such as the SWP, then the public agency must also make these determinations. Transfers facilitated by Reclamation through one of its facilities must be consistent with state law.

Public agencies that provide conveyance capacity to complete a transfer are statutorily required to make an additional determination in connection with approval of the use of their facilities that is not required of the SWRCB. This is that the transfer not unreasonably affects the overall economy or the environment of the county from which the water is being transferred. Upon determining that the three conditions regarding no injury are met, the public agency grants its approval to use its facilities to convey the transfer. Determinations made by the public agency in support of a decision are challengeable in court.

In the case of the CVP or SWP, Reclamation or DWR issues a letter or conveyance agreement consistent with no-injury provisions. The Water Transfers White Paper represents the process these two agencies have developed to address their obligations to assess no injury and other requirements. These are neither rules nor regulations. Public agencies that need to make these determinations in response to a request to use their conveyance to complete a transfer may borrow from this draft document or may choose to develop their own process.

The basis for the no-injury analysis has been whether the water made available for transfer is “real” or “new water,” that is, water that would not be in the watercourse downstream of the point of diversion absent the transfer. Unless a transfer is based upon “new water,” the water conveyed to the buyer will come at the expense of other water users or the environment (Anderson, David, 2012). Limiting transfers to the consumptive use portion of the diverted water has generally been the standard of the SWRCB in assuring that transfer water is “new water.” This standard was demonstrated in a SWRCB decision (Order WR 99 – 012) in which Natomas Central Mutual Water Company proposed a transfer in which efficiency improvements resulted in a reduction in diversion of 18,000 acre-feet. This efficiency improvement was recognized by the SWRCB. But, the SWRCB only recognized 1,995 acre-feet of the 18,000 acre-feet eligible for transfer. The 1,995 acre-feet were estimated consumptive savings from the removal of opportunistic vegetation when a canal was lined. Water rights are very complicated and there are exemptions to this generalization as it relates to conservation and transfer of “foreign” or imported water. It is beyond the scope of this appendix to explore these legal nuances. The noted citations (Slatter Scott, 2005) address the transfer of “foreign water” relative to the “no injury” rule.

Method of Making Water Available for Transfer

This discussion is focused on methods of making surface water available for water transfers. This is how water markets have traditionally operated in California. Potentially, a different type of market-based system may emerge at the basin level (intra-basin) as a means to achieve the goals of SGMA. This discussion reflects the experience of DWR in facilitating cross-Delta transfers. DWR's interpretation is neither rule nor regulation. More detailed information on the types of transfers is available in Section IV.

The most common methods of making water available for water transfers are (1) reservoir storage releases, (2) groundwater substitution, (3) crop idling, (4) crop shifting, and (5) water conservation. Water transfers based on crop shifting are rare.

Regardless of the source of water for the transfer, accounting and documentation must be provided to ensure that the water being made available is real, and above and beyond what would be in the hydrologic system except for the transfer. There is also a need to consider the potential transit losses of water and account for losses in the volume diverted by the buyer.

Reservoir Re-regulation

Reservoir re-regulation involves an increase release of water from a reservoir compared to normal operations. The transfer is conveyed downstream to a new point of diversion.

The release of additional water from the reservoir for transfer creates reduced storage than would not have existed except for the transfer. Consequently, more water must be retained the following year(s) to refill the vacated reservoir storage. The refilling of the reservoir must be accomplished in a manner that does not infringe on other downstream legal users of water; otherwise, "injury" occurs. To avoid injuring downstream users, sellers must refill the volume transferred at a time when downstream users would not have otherwise been able to capture the water, either in downstream reservoirs or direct diversion facilities.

Chapter 4 of the white paper, although specific to water transfers involving SWP and CVP facilities, provides detailed information on refill criteria, data needs to assure "real water," and monitoring requirements to verify no injury.

Groundwater Substitution

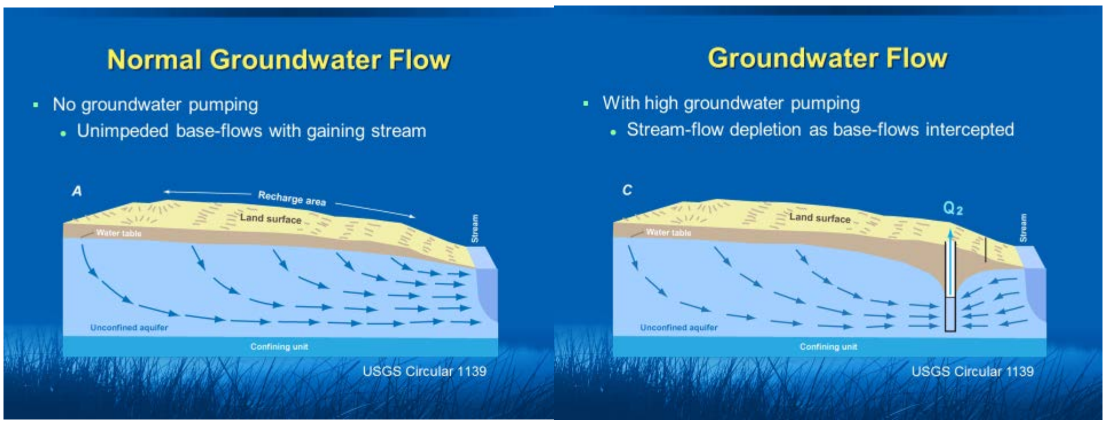
In a groundwater substitution transfer, the seller of transfer water uses groundwater in lieu of surface water rights entitlements for the period of the transfer. The forgone surface diversions are then available for the transfer. The quantity of surface water available is based on the quantity of groundwater actually pumped less any stream flow depletion losses.

Groundwater pumping will have an effect on surface-water flows. Any amount of water removed by pumping will impact the stream by an equal reduction in stream flow. This occurs because groundwater and surface water systems are interconnected. The impact of extracting groundwater is to reduce the rate of discharge of groundwater to surface water. If groundwater pumping is intensive enough, the direction of flows can be reversed such that the stream discharges to groundwater. The reduction of groundwater discharge to surface water is referred to as stream flow depletion. The impacts of groundwater pumping may take years, or even decades, to be realized.

Figure C-WT3 illustrates stream flow depletion. Stream flow depletion is not only an impact on other legal water users but also to the aquatic biological resources of the stream.

Groundwater extraction also has an impact on water quality of the stream, specifically temperature (Barlow, P.M. and Leake, S.A., 2012). Groundwater temperature is very stable and approaches the mean annual air temperature. In the summertime, groundwater discharge to a stream helps reduce surface water temperature and maintains stable stream temperature.

Figure C-WT3. Stream flow Depletion – (a) Gaining Stream (b) versus Losing Stream



Accounting for the impact of the transfer on stream flow is essential to determining the amount of new water available for transfer and to avoid injury to downstream water users. The amount and timing of the impacts cannot be directly measured, but they can be estimated through the use of mathematical models. Although the work required to accurately assess the appropriate stream flow depletion factor for a particular transfer can be time-consuming and costly, the assessment of an appropriate stream flow depletion factor is necessary to protect other legal users of water. DWR is improving the modeling tools to better assess the impacts of water transfers based on groundwater substitution in the Sacramento Valley. In the interim, DWR and Reclamation assess a 13 percent stream depletion factor for water transfers that are based on groundwater substitution and originate in the Sacramento Valley. This value is based on a rudimentary analysis of the potential impact to the CVP and SWP.

Beyond streamflow depletion, the amount of groundwater pumped and used in lieu of surface water needs to be monitored and documented. The amount of water pumped is the base amount of water for the transfer, minus any losses. The amount of transfer water diverted by the buyer must include the stream depletion estimate, and any conveyance losses.

A number of counties have adopted ordinances for the extraction and export of groundwater, including groundwater substitution transfers. Compliance with these ordinances is required to secure a letter or conveyance agreement for the use of CVP or SWP facilities to complete the transfer. Chapter 3 of the Water Transfers White Paper provides information on local ordinances north of the Delta relating to the transfer of groundwater. At the State level, California Water Code Section 1745.10 provides measures for the protection of the local groundwater resource from the origin of the transfer.

Crop Idling

In crop idling-based transfers, farmers idle fields that would have been planted. The water not used in crop production is made available for the transfer. The amount of water made available for transfer is based on the reduction in consumptive use. Consumptive use is calculated as the evapotranspiration of applied water (ETAW). ETAW is the portion of applied water that is evaporated from the soil and plant surfaces and actually used by the crop.

In most instances, water that infiltrates to the subsurface, whether through land application (irrigation) or leaky conveyance systems, is not considered consumptive water and not available for transfer as it remains part of the hydrologic system and available for use. On the other hand, if applied water infiltrates to unusable groundwater because of elevated salinity, then any water that is reduced from infiltrating is added to the water available for transfer.

Actual crop water requirements vary by crop, region, and growing season. It is not feasible to determine the actual ETAW for the specific conditions of each individual transfer, therefore, average ETAW values are used to estimate transfer water. Historic cropping patterns are used to establish baseline crop acreage. Baseline acreage is important to establish what would have been planted in the absence of the transfer. Land fallowing as part of a fallowing rotation, or that is fallowed as part of a cultural practice, does not qualify for water transfer. The crop idling must be for the purpose of making water available for transfer.

Idling agricultural land can result in impacts to the local economy from where the transfer originates. These could include reduction in employment, and reduced sales of goods and services that would have otherwise been used to support the agricultural operation. In order to minimize such potential economic effects, California statutes provide that the amount of water made available by land fallowing may not exceed 20 percent of the water that would have been applied or stored by the water supplier in the absence of the transfer (California Water Code Section 1745.05).

Water made available by crop idling is made available for transfer on the actual ETAW pattern during the year. Export capacity must coincide with the pattern of availability to allow export of the transfer water. Idling of rice crops in the Sacramento Valley is the primary means by which water is made available for transfer by crop idling process. Recall that transfers across the Delta are limited to July through September. Transfer water from rice idling is typically made available from May through September and the May and June water (pre-transfer period) accounts for 40 percent of the seasonal rice water use. Unless storage capacity upstream of the export location is available, any water made available from crop idling outside the transfer window cannot be exported and the transfer is not feasible. Storage for the May and June rice water is only available for a limited number of entities. As a result, the potential for rice idling water transfers is limited by the risks of potential conveyance failures across the Delta and by lack of storage for water that is made available in May and June, prior to the transfer period for through Delta transfers. Crop idling transfers that are completed wholly within the Sacramento Valley are not subject to these limitations (conveyance failures or storage of pre-transfer period water as per the biological opinions).

Crop shifting

Water transfers based on crop shifting involve substituting a lower water-using crop (one with a lower ETAW) for a more water intensive crop, specifically for the purpose of making water available for transfer. Transfers based on crop shifting are rare. A cropping history is required to establish baseline cropping patterns.

The water available for transfer as a result of crop shifting is the difference between the ETAW of the historic crop type and the alternate lower water-intensive crop. Crop shifting transfers are only practical in regions where the agricultural land is suited to multiple crop types, allowing a shift to an alternate crop. The restrictions on export of transfer water noted in Section 4.3 Crop Idling, apply to crop shifting as well. Proposed crop shift should be only for the purpose of making water available for transfer and should not be part of the historic cultural practices on the parcel for which water is being made available.

Water conservation WUE

Generally, only those conservation measures that result in a reduction in the consumptive use of water, or prevent water from discharging to an unusable water supply, make water available for transfer.

Conservation measures such as lining a canal or replacing an unlined ditch with a pipe may generate water for transfer to the extent that opportunistic vegetation is eliminated or surface or groundwater discharges to an unusable basin are eliminated. Documentation of the conditions, including water diversion and use, before and after the conservation measures were implemented, is necessary to demonstrate the amount of transferable water. Transfers based on implementation of water conservation measures have been limited, because most conservation programs do not meet the tests.

References and Sources of Additional Information

The Fresno Bee, June 5, 2014. Clever Water Trade Saves Citrus Trees in Terra Bella. By Mark Grossi. http://www.fresnobee.com/news/state/california/water-and-drought/article19520958.html

The Fresno Bee, July 26, 2010. Valley-L.A. water deal may be in works. By Mark Grossi. http://www.mwdoc.com/Uploads/Valley-L.A.WaterDealInworks.pdf

Lund et al., 1992. Recent California Water Transfers: Emerging Options in Water Management. Report No. 92-1 Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of California

Hanak, Ellen and Stryjewski, Elizabeth, 2012. California's Water Market, By the Numbers: Update 2012. Public Policy Institute of California.

The Times Herald, July 19, 2014; Drought pushing water prices to record levels; By Lisa M. Krieger; http://www.timesheraldonline.com/article/ZZ/20140719/NEWS/140717019

California Water Code 1810(d) This use of a water conveyance facility is to be made without injuring any legal user of water and without unreasonably affecting fish, wildlife, or other instream beneficial uses and without unreasonably affecting the overall economy or the environment of the county from which the water is being transferred.

DRAFT Technical Information for Preparing Water Transfer Proposals; Information for Parties Preparing Proposals for Water Transfers Requiring Department of Water Resources or Bureau of Reclamation Approval (Water Transfers White Paper), December 2015. (http://wwwdwr.water.ca.gov/watertransfers/docs/2016_Water_Transfer_White_Paper.pdf)

Bureau ·of Reclamation's Interim Guidelines for Implementation of Water Transfers under Title XXXIV of Public Law 102-575 (Water Transfer. (http://www.usbr.gov/mp/cvpia/3405a/docs/int-guide-imp-water-trans.pdf)

For more in-depth treatment of the "no injury" rule and "real water" determinations, the reader is referred to Anderson, David. 2012. Water Transfer Approval: Assuring Responsible Transfers. DWR. http://www.water.ca.gov/watertransfers/docs/responsible_water_transfers_2012.pdf

ORDER WR 99 – 012 – Natomas Central Mutual Water Company petition to transfer. 1999.

Slatter Scott. *A Prescription for Fulfilling the Promise of a Robust Water Market* in Volume: 36 McGeorge Law Review (2005), pg. 263.

Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p. (Also available at http://pubs.usgs.gov/circ/1376/.)

Department of Water Resources, Agricultural Land and Water Use Estimates. (http://www.water.ca.gov/landwateruse/anlwuest.cfm)

Details of the transfer process, and information for special category of transfers that require additional considerations can be found in the following:

- A Guide to Water Transfers, July 1999. CA State Water Resources Control Board (http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/watertransferguide.pdf); A comprehensive manual for water transfers practitioners and provides both general and specialized information including transfers from the Central Valley Water Project (CVP). Some of the information in this Guide is outdated but materially useful.

- Guidelines for the Implementation of Water Transfers Under the Central Valley Improvement Act, February 1993. (http://www.usbr.gov/mp/cvpia/3405a/docs/int-guide-imp-water-trans.pdf) Includes information specific to CVP contractors that wish to transfer portions of their allocations.

- DRAFT Technical Information for Preparing Water Transfer Proposals; Information for Parties Preparing Proposals for Water Transfers Requiring Department of Water Resources or Bureau of Reclamation Approval, December 2015. (Water Transfers White Paper) (http://wwwdwr.water.ca.gov/watertransfers/docs/2016_Water_Transfer_White_Paper.pdf) Water transfers that require the use of State Water Project (SWP) or CVP facilities (pumping and conveyance) to complete the transfer.

- Water Transfers and the Delta Plan; A Report to the Delta Stewardship Council, September 16, 2015, Prepared by DWR in consultation with the SWRCB A report prepared for the Delta Stewardship Council by the California Department of Water Resources (DWR) in consultation with the State Water Resources Control Board (SWRCB). This report describes the management of water transfers during the drought and including steps DWR, SWRCB, and the U.S. Bureau of Reclamation (Reclamation) are undertaking to streamline and expedite water transfers.

Additional sources of information for water transfers include the following websites from agencies with approval authority over water transfers or which facilitate water transfers.

State Water Resources Control Board, Temporary Water Transfers Information and Guidance.
http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/infosheets/infosheet_ttransfer.pdf

State Water Resources Control Board, Water Right Petitions.
http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/

State Water Resources Control Board, Water Transfers Program.
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Department of Water Resources, Water Transfer. http://www.water.ca.gov/watertransfers/

US Bureau of Reclamation, Water Transfers. http://www.usbr.gov/mp/cvpia/3405a/