Matching Water Quality to Use

Photo caption. Warning sign that nonpotable water is being used for landscape irrigation.

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Chapter 16. Matching Water Quality to Use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same quality water. One common measure of water quality is its suitability for an intended use; a water quality constituent often is only considered a contaminant when that constituent adversely affects the intended use of the water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be adequate for some uses. An example of this would be a water supplier choosing to use a groundwater source for municipal use, which requires less treatment before delivery, over a natural stream. The benefit to the municipal user potentially could be reduced disinfection byproducts in the delivered drinking water source, and the secondary benefit would accrue to the natural riparian system as water that would be left instream. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different uses. The use of other water sources, again, like recycled water, can serve as a new source of water that substitutes for uses not requiring potable water quality. Instream uses are directly influenced by discharges from wastewater treatment and stormwater flows and these source discharges can provide benefits and challenges to uses such as aquatic life and recreation.

Matching Water Quality to Use in California

See article, "Definitions of Beneficial Use for Water Quality and Water Rights," in Volume 4, the Reference Guide.

As part of the nine Regional Water Quality Control Boards (Regional Water Boards) Basin Planning efforts, up to 25 water quality beneficial use categories for water have been identified for mostly human and instream uses (see the article, "Definitions of Beneficial Use for Water Quality and Water Rights," in Volume 4, the Reference Guide). For this strategy, the beneficial uses discussed are primarily water quality-related beneficial uses. A second definition of beneficial uses of water is also defined by the California Code of Regulations for the purposes of applying for a water right to appropriate water. These two definitions of beneficial uses do overlap but do differ enough that one needs to be aware of the distinction (see Cal. Code Regs., tit. 23, §§ 659-672).

Human uses can be categorized as consumptive—such as municipal, agricultural, and industrial supplies—and non-consumptive—such as navigation, hydropower generation, and recreation. Instream uses include aquatic ecosystem uses, fish migration, spawning, and preservation of rare, threatened, and endangered species. Matching water quality to most of these uses is important because, except for municipal and industrial uses, water is generally used as-is, i.e., without treatment. In addition, aquatic organisms are more sensitive to some pollutants than humans. For example, the presence of dissolved metals at low concentrations can be lethal to sensitive fish species.

Matching Water Quality to Agricultural Use. Farmers currently match crops to the available water quality. In general, irrigation water should contain levels of constituents such as salinity and boron that will not inhibit the yields of some of the crops grown. Conversely, agricultural water supplies that have low levels of salts may require adding gypsum to improve percolation. Agricultural water supplies may require filtration to remove particulate matter that could clog low pressure irrigation systems and reduce soil infiltration rates. As an extreme case, Imperial Irrigation District runs all water that it diverts from the Colorado River at Imperial Dam through siltation basins to remove suspended particulates before the water is released into the All American Canal. In setting objectives for the reasonable protection of agricultural use in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, the Regional Water Boards examined the suitability of soils to determine anticipated crop types and set the salinity objectives to meet the needs of these crop types.

Matching Water Quality to Instream and Ecosystem Use. Ambient, instream water must be suitable to support a wide range of aquatic habitats and conditions. Thus, water quality for instream uses generally must meet physical, chemical, and biological objectives specific to the habitat and instream needs. One particular water quality objective that greatly affects fisheries is temperature. An example of an effort made to match water quality to an environmental use for temperature is the Temperature Control Device at Shasta Dam, which was built to better match water temperature to the reproductive needs of salmonid fish downstream. When viewed from a watershed level, decisions about whether to use instream versus out-of-stream sources such as groundwater and recycled water to meet future municipal and agricultural demands may result in the decision to leave water instream in favor of out-of-stream alternatives.

Matching Water Quality to Drinking Water Use. In order to avoid the additional cost of treatment, and to provide multiple barriers of protection for public health, it is best that drinking water supplies start with the highest quality source water reasonably possible. Historically, California's urban coastal communities—Los Angeles, San Francisco, Oakland and Berkeley—constructed major aqueducts to such sources as Hetch Hetchy, Owens Valley, and the Mokelumne River. Later, water supplies of lesser quality, such as the Sacramento-San Joaquin Delta and the Colorado River, were also tapped for domestic water supplies. In response, many utilities already manage water quality by blending higher quality water supplies with those of lower quality, as well as matching treatment process to source water quality, as required by regulation. For example, Metropolitan Water District of Southern California (MWD) dilutes high salinity Colorado River water with lower salinity water from the Sacramento-San Joaquin Delta (Delta), which improves public acceptance of tap water, as well as facilitates groundwater recharge and wastewater recycling projects. In turn, MWD dilutes the higher bromide and organic carbon levels in Delta water with Colorado River water, to help reduce disinfection by-products in treated water. In Solano County, higher quality, less variable Lake Berryessa water is blended with lower quality, highly variable North Bay Aqueduct water from the Delta. Likewise, many water suppliers have the

Box 16-1 Acronyms and Abbreviations

ACWD	Alameda County Water District
CALFED	CALFED Bay-Delta Program, a partnership of California State government and federal agencies
EWA	Environmental Water Account
GHG	greenhouse gases
IRWMP	integrated regional water management plan
MTBE	methyl tertiary-butyl ether
MWD	Metropolitan Water District of Southern California
NPDES	National Pollutant Discharge Elimination System
Regional Water Board	Regional Water Quality Control Board

capability to blend groundwater, local surface water, and imported supplies to achieve a desired water quality, although some utilities may instead choose to use water supplies based upon cost minimization or water rights considerations. Some water agencies even blend water (and water quality) from different levels of the same reservoir by using different intake levels. Many water management actions, such as conjunctive use, water banking, water use efficiency, and water transfers, intentionally or unintentionally, result in one type of water quality traded for, or blended with, another.

In the Upper Santa Ana River water basin, matching water quality to its effective use has been ongoing through a complex watershed-wide method. With the addition of the Seven Oaks Dam, water quality from the reservoir has improved, while at the same time, effluent flow downstream of the reservoir has increased. By using the increased flow of lower quality effluent for groundwater recharge, the region could increase its dry year sources while using the higher quality reservoir water for direct delivery of water to municipal uses.

The Central Valley Drinking Water Policy Workgroup, composed of interested stakeholders and technical experts, has initiated the technical work that will lead to adoption of a policy as a Basin Plan amendment by 2010. This multi-year effort is currently under way to develop a drinking water policy for surface waters in the Central Valley. As water flows out of the Sierra foothills and into the valley, pollutants from a variety of urban, industrial, agricultural, and natural sources affect the quality of water, which leads to drinking water treatment challenges and potential public health concerns. Current policies and plans lack water quality objectives for several known drinking water constituents of concern, such as disinfection by-product precursors and pathogens, and do not include implementation strategies to provide effective source water protection. The exact types of regulatory requirements that will be included in the drinking water policy have not been determined, but the goal is to develop a policy that provides clear guidance to ensure consistent source water protection.

Matching Water Quality to Industrial and Commercial Use. Business also matches water quality to use. Water used in high-technology applications is often purer than that used for drinking. For instance, Silicon Valley manufacturers and other businesses in the San Francisco Bay Area prefer higher quality Hetch Hetchy water to Delta or groundwater supplies that are also available in the region. For other uses, lower quality waters can be used. Cooling water used in production is often of a lower quality than that used for drinking. The Central and West Basin Municipal Water Districts offer different qualities of recycled water—at different costs—tailored to different uses, including process water for petroleum refining. At least one concrete plant in San Francisco captures and reuses its low quality storm water runoff for concrete production. The use of saline water and wastewater for power plant cooling has been promoted by the Regional Water Boards as evidenced by its Power Plant Cooling Policy adopted on June 19, 1975 (SWRCB, 1975).

Water Quality Exchange Projects. Regional opportunities could exist to exchange water to better match the water quality needs of the constituent service areas. Lower treatment costs and associated energy and greenhouse gas (GHG) emissions would result.

The CALFED Bay-Delta Program (CALFED) identified two potential water quality exchange projects, the San Joaquin Valley-Southern California Water Quality Exchange Program, and the Bay Area Water Quality and Supply Reliability Program, to improve water quality and water supply reliability—as well as disaster preparedness—on a regional basis. These programs could promote matching water quality to water use, with potentially no degradation to the ultimate use of the water. For instance, in the Bay Area, a local water agency with access to a water supply of relatively lower water quality could fund water recycling or water conservation projects in another agency's service area that has a higher quality water supply, in exchange for the higher quality water saved by those projects. The essential concepts are being pursued under the Bay Area Integrated Regional Water Management Plan (IRWMP) – Water Supply and Water Quality Functional Area Document (RMS, 2006).

Under the San Joaquin Valley-Southern California Water Quality Exchange Program, MWD is working with both the Friant Water Users Authority and the Kings River Water Association to investigate the feasibility of exchanging water supplies. MWD is interested in these exchanges to secure higher quality Sierra water supplies that could lower their cost of treatment and increase their ability to meet more stringent drinking water quality regulations. In return for participating in the water quality exchange, Friant and Kings are interested in securing infrastructure improvements, financed by MWD, which will increase water supply reliability for their members. In an exchange of this nature, however, increased salinity levels are the largest water quality issue. If water is drawn from a poorer quality supply and the basin has no outlet, then the salinity level in the groundwater will increase. This program is still being pursued as part of the September 2006 San Joaquin River Settlement (SJRRP, 2009; NRDC et al. v. Rogers et al., 2006).

Statutory Language. Several California Water Codes and California Code of Regulations provide guidance in the use of water, specify legal and regulatory requirements, and therefore define the potential for utilizing this strategy, including:

- The use of potable domestic water sources for nonpotable use is considered a waste and unreasonable use under Water Code section 13550.
- Existing water rights holders are free to use water sources that are polluted by waste to a degree which affects the water for other water quality beneficial uses over their normal higher quality water source, without fear of losing their water right due to non use (Wat. Code § 1010).

Potential Benefits of Matching Water Quality to Use

Agriculture. For agricultural and instream uses, water quality matching is an integral part of water quality management because there is generally no treatment of these water supplies prior to their use.

Drinking Water. For drinking water, appropriately matching high quality source waters can reduce the levels of pollutants and pollutant precursors that cause health concerns in drinking water. In addition, less costly treatment options can be used when water utilities start with higher quality source waters. In turn, water supply reliability is enhanced and multiple barriers of protection for public health are assured.

Municipal and Industrial. For municipal and industrial customers, using water high in salinity can damage plumbing, fixtures, water-using devices, and equipment, increasing economic costs. One study, conducted in 1998 by the US Department of the Interior and MWD, found that for every decrease of 100 milligrams-per-liter in salinity, there is an economic benefit of $95 million annually to MWD's customers.

Instream/Ecosystem Benefits. As a result of diversions of water from streams for beneficial human uses, downstream effluent releases from wastewater and storm water releases dominate the stream content. Without these effluent releases, many of these streams would have been dewatered due to appropriation of water. In addition, streams that once were ephemeral or intermittent have not become perennial due to effluent and storm water discharges. While this may be a change from the natural hydrology, it may be beneficial to some species of plants and animals.

Opportunities for Blending of Sources. Improved treated water quality and water supply reliability are also potential benefits of water quality matching for those agencies that have access to a diverse water supply portfolio. One example is the Santa Clara Valley Water District, its retail agencies, and other water suppliers along the South Bay Aqueduct, which have access to Delta water, Hetch Hetchy, local surface water, and groundwater. During droughts, seawater intrusion increases the level of salinity in Delta water supplies, including bromide. In such an event, agencies and regions with

water source flexibility could use more groundwater or local surface water, if available, both of which are relatively bromide-free. When water with high levels of bromide is disinfected, additional treatment costs may be incurred to minimize the formation of potentially carcinogenic disinfection byproducts.

Avoided Treatment Costs. Water that contains lower levels of salinity is a better match for domestic water quality uses and for irrigating salt-intolerant crops such as strawberries and avocados. As noted, some agencies blend water supplies to achieve a desired water quality, including salinity levels. If low salinity water supplies are unavailable, water utilities may have to treat high salinity water supplies to achieve a desired water quality. In the Chino Basin, utilities already dematerialize (desalt) water for domestic use, and Zone 7 Water Agency and Alameda County Water District (ACWD) have similar plans. At ACWD, for example, the capital costs alone of its new groundwater desalting project in Newark were $1.3 million per acre-foot per day of capacity, with operations and maintenance costs of $500 per acre-foot.

No-Cost Water Quality Exchange. In 2003 a "no-cost" water quality exchange was implemented between the Environmental Water Account (EWA), Kern Water Bank, and MWD. Under the exchange, EWA had purchased groundwater in Kern Water Bank and was seeking to avoid a storage fee for leaving the purchased water in the bank. MWD offered to receive EWA's purchased water in exchange for providing the EWA with a surface water supply later in the year when EWA could use the water. MWD benefited from the exchange because it received groundwater supplies with low total organic carbon and bromide levels during a period when MWD was unable to blend total organic carbon levels down with Colorado River supplies.

One example of a no-cost exchange is when an urban water user provides agricultural water users with surface supplies during the peak agricultural water demand period. During these periods, agricultural users would otherwise be forced to use groundwater and may face pumping constraints. In return for access to surface supplies, the agricultural user returns a similar amount of pumped groundwater during the fall-winter period when there is excess groundwater pumping capacity and undesirable levels of bromide and total dissolved solids in Delta surface supplies.

In addition to water-supply benefits, the use of Delta water in groundwater recharge and banking operations may provide water quality benefits as well as substantially reducing levels of turbidity, pathogens, and organic carbon upon withdrawal. Recharge and banking will result in better quality water with respect to these pollutants if the water is percolated.

Energy and Climate Change. Energy use may increase or decrease as a result of implementing this strategy, depending upon the situation. For most of the cases in which this strategy would be applied, energy use would be reduced due to the avoidance of treating the water to a higher quality than is needed for the use. Corresponding emissions would be increased or decreased depending upon whether the overall energy use is

increasing or decreasing as a result of implementation of this strategy. This increase in energy use must be weighed against the energy needed to transport alternative water for the same use.

Linkages to Other Resource Management Strategies

Pollution Prevention. This strategy has a direct link to the strategy for pollution prevention because maintaining water to its highest quality through pollution prevention allows greater potential uses of the water. The higher the quality of water, the greater potential there is to match quality to use.

Recycled Municipal Water. Recycled water that comes from a wastewater treatment plant is not treated and delivered as a potable water source. It is delivered to non-potable uses for which its quality is matched to its use.

Salt and Salinity Management. As water is used and reused, the potential for buildup of salts in the water makes the water less suitable for reuse. Salinity management is necessary to preserve the maximum potential uses of the water.

Groundwater/Aquifer Remediation. Matching water quality to use can be used as a management tool for aquifer protection. One example of this is in the Salinas groundwater basin where recycled water is to be supplied to agriculture in lieu of groundwater. This in-lieu recharge is used to combat further seawater intrusion.

Potential Costs of Matching Water Quality to Use

Water Exchange Costs. CALFED estimated that water quality exchanges could cost nearly $100 million (in 2004 dollars) during Stage 1 implementation. These costs can be broken down into costs to build the infrastructure to enable matching quality to use, the long-term conveyance costs, administrative costs (negotiation costs), swapping place of use, and institutional costs.

Infrastructure Costs. In most cases, costs for matching water quality to use will also include new conveyance systems to connect source waters different from those currently being used.

Conveyance Costs. Matching quality to use involves moving water from where it is available to where it is needed, incurring costs for energy, capacity, and hydraulic losses. These costs can come in the form of incentive payments for participants (e.g., the incentive motivating the Friant/Kings-MWD programs is MWD's willingness to invest in local infrastructure that will benefit the exchange partners).

Major Issues Facing Matching Water Quality to Use

Water Quality Exchanges

Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (see the Water Transfers chapter in this volume for further discussion).

Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (see the Water Transfers chapter in this volume for further discussion). In particular, water supplies are generally governed by place-of-use restrictions that must be addressed when exchanging water supplies. Moreover, water quality exchanges could have adverse third-party impacts, such as increasing the salinity of local groundwater, reducing the availability of higher quality instream water needed for fisheries, and limiting agriculture to salt-tolerant crops. For drinking water, an exchange could also trade bromide and organic carbon (precursors to contaminants with probable risks) for arsenic, one of the few known carcinogens regulated in drinking water. These water quality exchanges should be evaluated for their impact on energy use and GHG emissions in addition to the increase in supply and satisfaction of increased demand.

Effluent Dominated Streams

As a result of diversions of water out of streams and lakes for beneficial human uses, many streams in California have become dominated by effluent releases from wastewater and storm water releases. In addition, in the semi-arid West, many streams that were naturally seasonally intermittent or ephemeral have become perennial due to wastewater discharges or from nuisance flows from storm water systems. The conversion from intermittent/ephemeral stream types has changed the type of ecosystem that is being supported. For example, the native red-legged frog thrives in ephemeral stream systems. When these systems are converted to perennial streams, bull frogs, which are predators of the red-legged frog, can thrive and expatriate the red-legged from its habitat. Water pollution reduction is typically directed at eliminating the discharge of water from wastewater and storm water. This strategy could restore some native intermittent/ephemeral ecosystems but would also remove the “created” perennial ecosystems. Where effluent has replaced perennial flows, the removal of the effluent could convert historically perennial systems into ephemeral systems unless natural flows could be restored.

As water is withdrawn from streams and lakes in the rain-fed watershed, effluent discharges have been increasing. While effluent discharges might be seen as replacing the natural sources of water, in some watersheds, the timing and quality of the water is much different from natural conditions. For example, the effluent is typically warmer than the natural flow from formerly snow-melt fed or groundwater-fed streams and may contain more salts and other contaminants. This situation typically benefits non-native fish species. Native species are out-competed.

Usability of Water

There is often a high cost incurred by water supplies that become either unsuitable for certain uses, or very expensive to use, because of contamination. One specific

example, cited in a study by the Environment California Research and Policy Center, is the contamination of water supplies by methyl tertiary-butyl ether (MTBE, a gasoline additive that may cause cancer), which initially closed 80 percent of Santa Monica's drinking water wells. It forced that city to increase its dependence on imported water sources and later to install treatment facilities to reduce MTBE levels. More generally, nitrate has closed more public water supply wells in California than any other contaminant, often permanently redirecting the use of such contaminated water to irrigation (see the Groundwater/Aquifer Remediation chapter in this volume for further discussion).

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Salinity

Agricultural drainage, imported Colorado River water, and seawater intrusion in the Delta and coastal aquifers all contribute to increasing salinity in all types of water supplies, which can adversely affect many beneficial uses, including irrigation, fish and wildlife, and domestic use. The primary tool to reduce salinity impacts is matching water quality to use because many sources of salinity, such as seawater intrusion, are natural, and treatment to remove salinity is relatively expensive. If the source water has less saline, the discharge after use will also be less saline. Further, water supplies that are high in salinity increase the cost of recycling or recharging them into aquifers for subsequent reuse. The Regional Water Boards have recognized the need to develop salt management strategies to prevent high quality waters from being degraded due to salt discharges. The Santa Ana Regional Water Board has adopted a salt management plan, and the Central Valley Regional Water Board is working on a salt management strategy.

Operations Criteria for Storage and Conveyance

Most reservoirs and other projects, such as water transfers and the EWA, are operated to achieve goals and objectives related to water supply, power production, flood control, fish and wildlife protection, and even recreation—but not water quality. In the Delta, the water quality standards for project operations are for salinity and temperature, to protect agricultural, instream, and municipal and industrial uses. However, these ambient water quality standards do not reflect water user demand for lower salinity water supplies. Moreover, other parameters of concern for domestic uses, such as pathogens and organic carbon, do not have operating criteria and, further, do not have objectives in basin plans or discharge requirements in National Pollutant Discharge Elimination System (NPDES) permits.

Upstream and Downstream Partnerships

Presently, few partnerships exist between upstream source water areas, downstream water users, and the water users in between that affect water quality, resulting in a critical disconnect in the overall system. Such partnerships could lead to pollution prevention or trading opportunities that could result in more efficient water quality protection. For example, a downstream partner having interest in protecting water quality may wish to pay for projects or initiatives in the upstream partner's area of

influence. The State of California is encouraging these partnerships through grants funded by various bond measures to develop and implement IRWMP.

Ecosystem Restoration and Drinking Water Supplies

Some ecosystem restoration projects, such as wetlands restoration, may improve habitat and even some aspects of water quality, but at the same time, may degrade other aspects of water quality, such as the increase of mercury or organic carbon (from a drinking water perspective). The CALFED Ecosystem Restoration program has reviewed this potential conflict in matching water quality to use (DFG, 2009).

Recommendations to Better Manage Matching Water Quality to Use

1. The State should facilitate and streamline water quality exchanges that are tailored to better match water quality to use, while mitigating any adverse third-party impacts of such transfers, including the increase or decrease in net energy use and greenhouse gas emissions.

2. The State, local agencies, and regional planning efforts should review potential impacts on streams by projects aimed at eliminating discharge of wastewater or causing changes to the natural timing and quality of water and make recommendations on how to mitigate these impacts.

3. To facilitate water reuse downstream, the State should encourage upstream users to minimize the impacts of non-point urban and agricultural runoff and treated wastewater discharges.

4. The State should support the development of salt management plans for all watersheds where salt is a constituent of concern.

5. The State and local agencies should better incorporate water quality into reservoir, Delta, and local water supply operations, as well as facility reoperation and construction. For example, the timing of diversions from the Delta, and thereby the concentrations of salinity and organic carbon in those waters, could be better matched to domestic, agricultural, and environmental uses. Alternatively, the timing and location of urban and agricultural discharges to water sources, including the Delta, could also be coordinated with the eventual use of water conveyed by potentially impacted diversions. Facilities conveying municipal and industrial water could also be separated from those conveying water for irrigation.

6. The State, local water agencies, and regional planning efforts should manage water supplies to optimize and match water quality to the highest possible use (e.g., drinking water) and to the appropriate treatment technology.

7. Consistent with the watershed-based source-to-tap strategy recommended in the Pollution Prevention chapter, the State should help facilitate system-wide partnerships between upstream watershed communities and downstream users along the flow path, in order to seek ways to better match water quality to use. Ongoing integrated regional water management planning efforts are facilitating system-wide partnerships to better match water quality to use.

8. The State should support research into solutions to the potential conflicts between ecosystem restoration projects and the quality of water for drinking water purposes.

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