
CHAPTER 6.0 FRESOURCE MANAGEMENT STRATEGIES

6.1 Introduction

The *California Water Plan Update 2013* presents 30 standard resource management strategies (RMS) designed to help meet the water-related goals and objectives of integrated regional water management (IRWM) plans across the state. An RMS is a technique, program, or policy that helps local entities manage their water and water-related resources. The intent of the RMS standard is to encourage diversification of water management approaches as a way to mitigate for uncertain future circumstances, rather than relying on a single strategy or approach for addressing a regional issue. The RMSs are interrelated and each is to some extent dependent upon or complementary to others. Collectively, RMSs acknowledge that water management, whether within a single watershed or statewide, is a complex challenge that must balance environmental, societal, economic, and cultural drivers in order to maximize the beneficial uses of a finite and scarce resource. These strategies include considerations of assessed vulnerabilities and projected impacts of climate change on the region (please see Chapter 8 *Climate Change*, for a detailed discussion of climate change vulnerabilities and projected impacts on the region). RMS are grouped into categories based on the overall objectives of the California Water Plan:

- ◆ reduce demand;
- ◆ improve flood management;
- ◆ improve operational efficiency;
- ◆ increase water supply;
- ◆ improve water quality;
- ◆ practice resource stewardship; and
- ◆ recognize the connection between people and water.

An IRWM plan must consider, at a minimum, each RMS in the *California Water Plan Update 2013*; additional RMSs can be formulated as well, in response to regional conditions. All 30 standard RMSs were considered in formulating the IRWM Plan; however, three were determined inapplicable to the Plan area. Additional strategies were formulated pertaining to fire and fuels management, wastewater treatment, snow fences, and rainfed agriculture. Workgroups identified strategy recommendations tailored to the specific goals and objectives of the Plan for each of the 27 standard RMSs considered. Please see Chapter 5 *Goals and Objectives* for a detailed discussion of the intended benefits of the Plan.

Sections 6.2 and 6.3 present a brief summary of each standard RMS; how it supports the region's climate change adaptation objectives; an assessment of its applicability to the Upper Feather River (UFR) IRWM Plan area; and a brief statement of the number and nature of recommendations made by workgroups, if applicable. Specific strategy recommendations from each of the workgroups for all applicable RMSs are located in Section 6.4 – *Strategy Recommendations*.

The RMSs discussed in this chapter are incorporated into the process for development and review of individual projects under the IRWM Plan. Please see Chapter 9 *Project Development and Review Process* for a detailed description of the timing and review process for individual projects.

6.2 Selected RMSs and Applicability to Region

The following standard RMS apply to the Upper Feather River IRWM Plan area.

6.2.1 Reduce Water Demand

Water conservation is defined by California Water Code (CWC) Section 10817 as “the efficient management of water resources for beneficial uses, preventing waste, or accomplishing additional benefits with the same amount of water.” Thus, reduced water demand is not synonymous with water conservation, as increased efficiency can result from increases in benefits from the same amount of water, as well as from maintaining current levels of benefits from less water. In either case, increases in efficiency will tend to reduce waste and non-beneficial use of water resources, which will reduce present demand and/or allow for greater flexibility to meet future demand. Climate change has the potential to impact the volume and seasonal availability of water. As noted in Chapter 8 *Climate Change*, less precipitation and snowfall mean that current levels of water demand, if sustained, can stress the watershed and reduce the economic and environmental productivity of the region. Increasing efficiency of agricultural and urban water use could reduce demand, making the region more resilient to changes in precipitation patterns.

6.2.1.1 Agricultural Water Use Efficiency

The agricultural water use efficiency strategy describes the application of scientific processes to control agricultural water delivery and use, in order to achieve a beneficial outcome. It includes an estimation of net water savings or increased production resulting from implementing efficiency measures. Improvements in agricultural water use efficiency are expressed as yield improvements for a given unit amount of water, and can be estimated over individual fields or entire regions. The net water savings is the reduction in the amount of water applied, while maintaining or improving crop yield and agricultural productivity. Net water savings recognizes: 1) the uptake and transpiration of water for crop water use; 2) the role, benefits, and quantity of applied water that is recoverable and reusable in the agricultural setting; and 3) the quantity of irrecoverable applied water that flows to salt sinks--such as inaccessible or degraded saline aquifers--or that evaporates to the atmosphere and is unavailable for reuse.

Examples of measures that improve agricultural water use efficiency include:

- ◆ Hardware – improving irrigation and water delivery systems;
- ◆ Water management – reducing evapotranspiration and improving management of irrigation and water delivery systems; and
- ◆ Agricultural technology – breeding, genetically modified foods crops, fertilizers, technology, etc.

Currently, agricultural lands account for approximately 2.7 percent of the Plan area and are predominantly irrigated pasture rather than crops¹. A reduction in agricultural water demand can minimize the impacts of existing vulnerabilities and help increase agricultural resiliency to possible decreases in water availability in the future. The Agricultural Lands Stewardship Workgroup identified 16 recommendations for promoting agricultural water use efficiency, including education, data sharing, and technical assistance to agricultural land managers, as well as the use of best management practices in agricultural operations (Table 6.1).

6.2.1.2 Urban Water Use Efficiency

Urban water use efficiency strategies focus on reducing demand, as most municipal water is not available for reuse without treatment. The *California Water Plan Update 2013* includes 14 Demand Management Measures (DMMs) aimed at reducing urban water demand in California. These DMMs include internal water system audits, leak detection and repair, metering all connections and applying conservation

¹ Alfalfa and grass hay production are considered crops, as it can be harvested for sale and transport out of the area.

pricing, rebate programs for high-efficiency appliances, public outreach, and landscape surveys and water-efficient landscape guidelines.

Urban water use efficiency programs such as DMMs are targeted mainly at large urban water suppliers², and produce significant savings at large scales. Municipal water in the region is supplied by small districts serving fewer than 3,000 customers; however, increasing efficiency of municipal water use would provide important benefits in the region, especially through reducing demands on existing infrastructure and avoiding the need for costly expansion. The region's population increases significantly in summer months with an influx of seasonal residents and tourism. Infrastructure that increases urban water use efficiency throughout the year can help preserve a limited water supply, even during times of increased water demand and decreased water availability. The Municipal Services Workgroup identified seven recommendations for promoting urban water use efficiency, including implementing DMMs and funding incentive programs for disadvantaged communities (DACs) and small districts (Table 6-1).

6.2.2 Improve Flood Management

Flood management comprises policies and practices related to educating the public, preparing for, mitigating damages related to, responding to, and recovering from flooding, as well as protecting the natural and beneficial functions of floodplains. The Flood Management RMS is divided into four approaches:

- ◆ *Nonstructural* – land use planning, floodplain mapping, risk assessment, land acquisitions and easements, building codes and flood proofing, permanent relocation, flood insurance, flood risk awareness;
- ◆ *Structural* – levees and flood walls, channels and bypasses, retention and detention basins, culverts and pipes, streambank stabilization, reservoir and floodplain storage, inspection and vegetation management, sediment removal, repair of structures;
- ◆ *Restoration of natural floodplain functions* – promoting natural hydrologic, geomorphic, and ecological processes, protecting and restoring floodplain habitats, invasive species reduction; and
- ◆ *Flood emergency management* – flood preparedness, emergency response, post-flood recovery.

These approaches all address the impacts of flooding, the risk of which may increase with future changes in the regional climate. Increasing temperatures, reduced snowfall, and earlier snowmelt may increase the risk of wildfire. Where severely burned acres drain to avalanche and debris chutes, and alluvial fans, excessive bedload and debris can worsen erosion for significant distances downstream in flood events after a wildfire. Increased probability of rain-on-snow events can create higher than anticipated runoff peaks. Protecting the floodplains through structural, nonstructural, and restorative approaches supports the watershed's ecological health and builds resiliency to flood events.

6.2.2.1 Flood Management

The non-structural and structural approaches to flood management have limited applicability to the region, given the rural setting, small population, expectation of limited growth, the large percentage of public land, and by the location of most communities in upper watershed areas away from active floodplains. The region does not face significant issues of new development in floodplains. Flood debris can block or cause floodwaters to overtop levees, channels, or culverts and bridges bypasses. Flood

² Urban water suppliers are defined in the California Water Code as entities that supply 3,000 or more customers or deliver 3,000-acre feet of water annually.

related sedimentation of streams, culverts, and reservoirs is a significant issue in the watershed, but is addressed in the Sediment Management RMS and through road and bridge and floodway improvement projects in the Plan.

A most significant flood management issue in the region is the loss of natural floodplain functions due to declining capacity of meadows, erosion and headcutting of streams, and reduced ability of the watershed to hold and release floodwaters. Rain-on-snow events, the severity and frequency of which may increase with climate change, can accelerate the loss of these functions. The Floodplains, Meadows, and Waterbodies Workgroup identified one recommendation: restoration of natural floodplain function to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and release floodwaters (Table 6-1).

6.2.3 Improve Operations Efficiency and Transfers

Improving operational efficiency of water management refers to exploring ways water infrastructure can be used to maximize regional and inter-regional beneficial uses of existing water supplies. Water infrastructure elements such as dams, canals, and pumping stations are often developed for single purposes by independent entities, but could be integrated into a more holistic water management network that uses all available water to maximize benefits. Improving operational efficiency may require changes to administration and facilities operations more so than new infrastructure, though minor modifications to facilities or construction of new conveyance interties may be necessary. Improving efficiency and connectivity of available water supplies also prepares the region to maintain water availability in anticipation of rising temperatures and decreased snowfall as a result of climate change.

6.2.3.1 Conveyance – Regional/Local

Regional conveyance is the conveyance or distribution of water from locally developed sources to end users located within the same watershed or river system. Conveyance systems are necessary to achieve benefits from virtually every other facet of local and regional water management such as recycling, water transfers, and both surface and groundwater storage. Improvements in system conveyance capacity can be achieved by locating and widening bottlenecks that constrict the movement of water. Conveyance capacity improvements can increase reliability without requiring increased supplies by increasing operational flexibility to move water between storage locations and points of use. Other potential benefits of improving regional conveyance capacity include improved water quality, reduced impacts to fisheries and streams, enhanced opportunities for conjunctive use, and increased surface and groundwater storage.

The most significant regional conveyance issues in the region are aging infrastructure and inadequate capacity. Continuing to study how anticipated climatic changes will place additional pressure on these systems can guide infrastructure and ecosystem upgrades that will respond to both current and future challenges. The Agricultural Lands Stewardship Workgroup identified six recommendations to improve regional conveyance, including repair and upgrade of aging infrastructure, replacement or improvement of canals, invasive weed control, and an improved description of the existing management system and capacity needs (Table 6-1).

6.2.3.2 System Reoperation

System reoperation describes the improvement of existing operations and management procedures of water facilities to meet needs more efficiently and reliably, rather than relying solely on infrastructure improvements. Minor physical changes to facilities may also be required. Examples of system reoperation include:

- ◆ Integration of flood protection and water supply systems to increase water supply reliability and flood protection, improve water quality, and provide for ecosystem protection and restoration;
- ◆ Reoperation of existing reservoirs, flood facilities, and other water facilities in conjunction with groundwater storage to improve water supply reliability, flood hazard reduction, and ecosystem protection and to reduce groundwater overdraft;
- ◆ Promotion of more effective groundwater management and protection and greater integration of groundwater and surface water resource uses, and;
- ◆ Improvement of existing water conveyance systems to increase water supply reliability, improve water quality, expand flood protection, and protect and restore ecosystems.

System reoperation focuses primarily on large-scale integration of State Water Project, Central Valley Project, and regional water project facilities. The Plan area includes several dams operated by the State Water Project, as well as hydroelectric facilities operated by Pacific Gas & Electric, and numerous facilities operated by the U.S. Forest Service and local water districts (see Table 3.11 for a list of dams in the Region). Opportunities for system reoperation in support of water management outside the watershed are necessarily mediated through management and operation of Oroville Dam; however, local benefits such as improved fisheries habitat, water quality, groundwater recharge, and flood management could accrue from reoperation of dams and other water facilities in the watershed. System reoperation in response to climate change impacts, such as decreased streamflow and precipitation, can help the region's hydropower resources along the Stairway of Power prepare for unavoidable impacts to hydropower production and may also enable communities dependent on that energy be better equipped for a diminished supply of power. The *Forest and Water Balances Study* (Appendix 3-1) considers the effects of forest densification on groundwater recharge and streamflows with implications for downstream dams and facilities.

The Municipal Services Workgroup identified three recommendations for promoting system reoperation: collaborating with federal, state, and local agencies on system reoperation studies, performing system audits, and conjunctive management (Table 6-1).

6.2.3.3 Water Transfers

Water transfers are sometimes seen as merely moving water from one beneficial use to another; however, in practice many water transfers become a form of flexible system reoperation linked to many other water management strategies. These strategies include surface water and groundwater storage, conjunctive management, conveyance efficiency, water use efficiency, water quality improvements, and planned crop shifting or crop idling for the specific purpose of transferring water. These linkages often result in increased beneficial use and reuse of water overall and are among the most valuable aspects of water transfers. Transfers also provide a flexible approach to distributing available supplies for environmental purposes. This ability to conserve, increase reliability, or build additional water supply through transfers helps the region adapt to climate change in the face of possible decreases in typical year flows.

A water transfer is a temporary or long-term change in the point of diversion, place of use, or purpose of use due to a transfer, sale, lease, or exchange of water or water rights. Transfers can be between water districts that are close by or across the state, provided there is a means to convey or store the water. A water transfer can be a temporary or permanent sale of water or a water right by the water right holder, a lease of the right to use water from the water right holder, or a sale or lease of a contractual right to water supply. Water transfers can also take the form of long-term contracts for the purpose of improving long-term supply reliability. Generally, water is made available for transfer by five major methods:

1. Transferring water from reservoir storage that would otherwise have been carried over to the following year. The expectation is that the reservoir will refill during subsequent wet seasons.
2. Pumping groundwater (groundwater substitution) instead of using delivered surface water.
3. Transferring previously banked groundwater either by directly pumping and transferring the banked groundwater or by pumping the banked groundwater for local use and transferring surface water that would have been used locally.³
4. Reducing the existing consumptive use of water through crop idling or crop shifting to make water available.
5. Water that seeps to saline or excessively polluted groundwater is irrecoverable without extensive treatment. Deep percolation, whether from canal seepage or from irrigated fields that would otherwise seep to unusable groundwater, can be captured and transferred if the seepage loss is prevented by applying water-use efficiency measures. Thus, unrecoverable seepage conserved from lining a canal or by switching from flood irrigation to drip can be transferred.

Opportunities for inter-regional water transfers in the region are limited and somewhat controversial at present; however, the large number of and diversity of water management entities within the watershed creates significant opportunities to increase regional efficiencies through water transfers within the region. The Municipal Services Workgroup identified three recommendations for increasing benefits from water transfers, including expanded groundwater management and monitoring programs, and exploring opportunities for intra-, inter-, and interstate- basin transfers (Table 6-1).

6.2.4 Increase Water Supply

Strategies to increase water supply include not only precipitation enhancement and conservation, but also conjunctive management of surface and groundwater as a single integrated source, enhanced surface storage, and recycling.

6.2.4.1 Conjunctive Management

Conjunctive management is the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Surface water and groundwater resources typically differ significantly in their availability, quality, management needs, and development and use costs. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit. Conjunctive management thus involves the efficient use of both resources through the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin that is planned to be used later by intentionally recharging the basin when excess water supply is available, for example, during years of above-average surface water supply or through the use of recycled water.

A sustainable conjunctive water management program consists of several components that include investigating the groundwater aquifer characteristics, estimating surface water and groundwater responses, and appropriate monitoring of groundwater level and quality. In addition, reliable institutional

³ Groundwater banks consist of water that is “banked” during wet or above-average years. The water to be banked is provided by the entity that will receive the water in times of need. Although transfers or exchanges may be needed to get the water to the bank and from the bank to the water user, groundwater banks are not transfers in the typical sense. The water user stores water for future use; this is not a sale or lease of water rights. It is typical for fees to apply to the use of groundwater banks.

systems for ensuring environmental compliance, providing long-term system maintenance, and managing contractual and legal features of the program are critical to sustainability. Conjunctive management may become more important as precipitation variability increases throughout the region as a result of climate change.

Conjunctive management would potentially benefit the region through better management of stormwater and groundwater. Because of the complex regional geology, there are 14 groundwater basins in the Plan area (Chapter 3 *Region Description* for a description of the groundwater basins in the Plan area), only one of which has a basin plan. The Agricultural Lands Stewardship Workgroup identified nine recommendations for promoting conjunctive management in the region, including public education, data gathering, monitoring, management plans for all groundwater basins, and increased groundwater recharge (Table 6-1). The Floodplains, Meadows, and Waterbodies Workgroup identified five recommendations to promote conjunctive management in the Plan area, including public education, increased monitoring, improved coordination with tribes and other local agencies, and restoration of wet meadows (Table 6-1).

6.2.4.2 Precipitation Enhancement

Also called cloud seeding, precipitation enhancement is a form of weather modification that artificially stimulates clouds to produce more rainfall or snowfall than they would produce naturally, by injecting substances into the clouds that enable snowflakes and raindrops to form more easily. Precipitation enhancement projects typically use silver iodide, supplemented with dry ice for aerial application. Occasionally, liquid propane or hygroscopic materials are used instead of silver iodide. In 2011, there were a total of 15 precipitation enhancement programs active in California, including one in the Lake Almanor area that is managed by Pacific Gas & Electric (PG&E). Most of the agencies or districts doing precipitation enhancement projects suspend operations during very wet years once enough snow has accumulated to meet their water needs. Additional precipitation generated by cloud seeding could offset demand on other water sources that may face diminished supplies as a result of climate change.

Precipitation enhancement could potentially benefit the region by increasing snow pack, but may have limited potential for further application beyond present levels, particularly in view of current climate trends. Natural precipitation decreases from west to east and from north to south in the Plan area, and the potential to artificially enhance precipitation from storms may be low in most of the upper watershed of the Middle Fork. Enhancing precipitation over the western slope of the Sierra Crest where natural precipitation is highest could result in more flow into Lake Oroville, but would not benefit most of the watershed, since most of the inhabited area and impoundment facilities lay east of the Sierra Crest. In addition, precipitation enhancement is often viewed with skepticism by local stakeholders because of concerns over its effects on environmental and human health.

The Floodplains, Meadows, and Waterbodies Workgroup identified two recommendations to increase knowledge regarding the effectiveness and health consequences of existing precipitation enhancement projects in the region, and to increase involvement of academics and local citizens in research related to the effects of cloud seeding on local communities (Table 6-1).

6.2.4.3 Municipal Recycled Water

The California Water Code (CWC) provides the following definition for recycled water: "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 considered a valuable resource" (CWC Section 13050(n)). Recycled water can be divided into two categories: potable reuse and non-potable reuse. Potable reuse involves introducing recycled water directly into the domestic water supply or indirectly through a reservoir or

groundwater basin. Non-potable reuse involves using recycled water for irrigation, agriculture, or industry. Typically, treated wastewater is discharged into rivers and streams as part of permitted disposal practices. Discharged water then comingles with the stream or river that may be a water source for downstream communities or agricultural users. Treated wastewater discharged into streams or shallow groundwater in the region become part of the streamflow. Or, as a consequence of increasing direct municipal recycled water use, the volume of treated water discharged into streams may be reduced, potentially reducing instream flows, including beneficial uses. Recognizing this, the CWC requires that prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater, the State Water Resources Control Board (SWRCB) reviews proposed changes to ensure potential impacts on beneficial uses are considered.

Making municipal recycled water available for irrigation and other agricultural uses would be a substantial benefit in the watershed. In the face of reduced snowpack and precipitation as a result of climate change, recycled water can reduce pressure on other surface and groundwater resources to meet demand. The Municipal Services Workgroup identified five recommendations to promote the use of municipal recycled water in the region, including funding, public outreach, and feasibility studies (Table 6-1).

6.2.4.4 Surface Storage – Local/Regional

Surface storage is the term for the use of human-made, aboveground reservoirs to collect water for later release when needed. Many California water agencies rely on surface storage as a part of their water distribution systems. Reservoirs also play an important role in flood control and hydroelectric power generation throughout California.

In addition, surface storage is often necessary to implement, or to maximize the benefits from, other water management strategies such as water transfers, conjunctive management of surface and groundwater, and conveyance improvements. There are two general categories of surface storage reservoirs: 1) those formed by damming an active, natural river; and 2) offstream reservoirs, which require a human-made diversion or pumping of water from a river into storage.

A significant amount of the larger local and regional surface storage in the region is by agencies managing water for uses downstream of Lake Oroville (Department of Water Resources/DWR) or for hydroelectric power generation (PG&E). Surface storage for local uses is generally in small impoundments (see Table 3-11 for a list of dams in the Region); exceptions are DWRs' Antelope Reservoir, which is managed for recreation, agricultural irrigation and instream flows, and Lake Davis, which contains Plumas County's State Water Project (Table A) water for domestic recreational and environmental uses. Increasing surface storage capacity in the region could benefit local users as well as increase flexibility to respond to climate-induced changes in timing of water availability and reduced watershed retention.

The Floodplains, Meadows, and Waterbodies Workgroup identified four recommendations to increase surface storage in the Plan area, including increasing capacity of existing facilities and timing water releases for agricultural and environmental uses, restoring meadows, wetlands, and riparian areas, and methods, studies, and tools for analyzing costs and benefits of future projects (Table 6-1).

6.2.5 Improve Water Quality

Protecting and improving water quality is a major priority of water management in California. Along with providing sufficient supply of water for all beneficial uses, water management agencies must ensure that the supplied water is of adequate quality to provide those beneficial uses. Drinking water and environmental uses require high-quality water, as do some industrial uses, while agriculture and other

uses may be met by water that is not of sufficient quality for drinking. Preventing pollution and the accumulation of salts in the water supply, along with matching water quality to use are important tools for ensuring that the water supply meets the needs of all beneficial uses that rely on it. Addressing the following resource management strategies to improve water quality can help the Upper Feather River watershed adapt to anticipated impacts from climate change, including wildfires, increased temperatures, and changes in precipitation.

6.2.5.1 Drinking Water Treatment/Distribution

Drinking water regulations mandated by the California Safe Drinking Water and Toxic Enforcement Act apply to all public water systems, regardless of ownership. The U.S. Environmental Protection Agency (EPA) is responsible for ensuring implementation of the federal Safe Drinking Water Act and related regulations. The state has primacy for the public water system regulatory program in California and works closely with the EPA to implement the program. In addition, local agencies such as county environmental health departments are responsible for regulating small public water systems (typically those serving fewer than 200 homes) in most counties. The EPA directly provides regulatory oversight for tribal water systems.



Water tanks (Source: Plumas-Eureka CSD)

Common surface water treatment facilities include basic chlorine disinfection; sedimentation basins; filtration; and more recent technical advances, such as membrane filtration, ultraviolet light, and ozonation to meet pathogen removal and/or inactivation as well as disinfection requirements while reducing the formation of disinfection byproducts. Common facilities for groundwater sources that require treatment are chemical removal and/or blending facilities.

Issues of water quality in the watershed include aging and inadequate storage and distribution systems that are prone to leakage and backflow, outmoded treatment facilities, and high levels of arsenic in some water sources, which may be made worse as the frequency and severity of catastrophic wildfires increase in the region due to climate change. The Municipal Services Workgroup identified five recommendations for improving drinking water quality in the region, including funding to improve and repair aging infrastructure, upgrading and modernizing treatment facilities, and developing incentives to promote reduction of waste (Table 6-1).

6.2.5.2 Groundwater/Aquifer Remediation

Contaminants in groundwater can come from many sources, naturally occurring and anthropogenic. Examples of naturally occurring contaminants include heavy metals and radioactive constituents, as well as high concentrations of various salts from specific geologic formations or conditions. In addition, groundwater can be contaminated by anthropogenic sources with organic, inorganic, and radioactive constituents from point and nonpoint sources. These anthropogenic sources include industrial sites, mining operations, leaking fuel tanks and pipelines, landfills, impoundments, septic systems, and urban and agricultural activities. The contaminant having the most widespread and adverse impact on drinking

water wells is arsenic, followed by nitrates, naturally occurring radioactivity, industrial and commercial solvents, and pesticides. Groundwater in some of the region is naturally high in arsenic.

Groundwater remediation removes contaminants that affect beneficial use of groundwater, by passive or active methods. Passive groundwater remediation allows contaminants to degrade biologically or chemically or disperse in the aquifer (in situ) over time. Active groundwater remediation involves either treating contaminated groundwater in situ or extracting contaminated groundwater from the aquifer and treating it outside of the aquifer (ex situ). Active in situ methods generally involve injecting chemicals into the contaminant plume. Ex situ methods for treating contaminated groundwater can involve physical, chemical, and/or biological processes. Remediating contaminated groundwater sources in the region may increase available water for human and environmental use, and create additional space for water transfers and storage. As climate change may reduce availability of existing water supply, additional supply from remediated groundwater could help buoy the water system to meet demand.

The Municipal Services Workgroup identified four recommendations to enhance groundwater remediation in the Plan area: protecting source waters, funding for monitoring and wellhead treatment, and in situ and ex situ treatment programs.

6.2.5.3 Matching Water Quality to Use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same water quality. 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. For example, high-quality water can be used for drinking and industrial purposes, and lower-quality water can be adequate for other uses. Some new water supplies, such as recycled water, can be treated for a wide range of purities that can be matched to different uses. The use of other water sources, such as 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 discharge from wastewater treatment and stormwater flows; these source discharges can provide benefits and challenges to uses such as aquatic life and recreation and downstream users.

Human uses are categorized as consumptive (e.g., municipal, agricultural, and industrial supplies) and non-consumptive (e.g., navigation, hydropower generation, and recreation). Instream uses also 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 water is generally used as is (i.e., without treatment) with the exception of domestic and industrial uses.

Strategies for matching water quality to use include blending of water from different sources, water exchanges among entities that need water of different quality, and tailoring treatment of recycled water to the intended use. Most of these strategies are of limited applicability in the region, as there is little potential for water exchanges or blending among sources of different quality because most water in the Plan area originates in the Plan area. Recycling municipal water for irrigation use, and sustaining instream environmental and other surface water needs through groundwater recharge, are two areas of potential benefit for water management in the region.

6.2.5.4 Pollution Prevention

Pollution prevention is defined as reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less toxic substances, implementation of practices or conservation techniques that reduce the generation and/or discharge of pollutants, and the application of innovative and alternative technologies which prevent pollutants from entering the environment prior to

treatment. Sources of water pollution are categorized into two types: point source and nonpoint source (NPS). In California, point-source pollution prevention is addressed through Water Code Section 13263.3(d)(1), which authorizes the SWRCB, a Regional Water Quality Control Board (RWQCB), or a publicly owned treatment works to require a discharger to prepare and implement a pollution prevention plan. A point-source discharger is defined per Water Code Section 13263.3(c) as any entity required to obtain a National Pollutant Discharge Elimination System (NPDES) permit or any entity subject to the federal pretreatment program. A nonpoint discharger is any discharger not covered by a NPDES permit. Pollution prevention can contribute to the protection of water quality for beneficial uses by protecting water at its source and therefore reducing the need and cost for other water management and treatment options. By preventing pollution, water supplies can be used and reused by a greater number and variety of water users. Sources of pollution in the watershed include abandoned mine sites; agricultural runoff; livestock; watercraft; aging or inadequate septic fields; runoff from roads; and residential pollution such as pesticide and fertilizer use, and oils from vehicle.

The impacts of climate change identified in the vulnerability assessment include decreased precipitation and stream flows, increased temperatures, and increased risk of wildfire. All of these impacts can stress the watershed by increasing in-stream temperatures, decreasing summertime flows, and worsening sedimentation including losses of streamside and riparian vegetation as a result of increased wildfires. In the face of these additional challenges anticipated in future years, preventing pollution where possible is especially important. Doing so can reduce compounding stress on ecosystems and help build resilience across the watershed.

The Agricultural Lands Stewardship Workgroup identified eight recommendations to improve pollution prevention efforts in the region, including protection of source waters, livestock fencing of riparian areas, sealing of abandoned wells, sediment control, invasive species control, and management and monitoring of contaminants that lead to listing of streams as impaired under Section 303(d) of the Clean Water Act (Table 6-1). The Floodplains, Meadows, and Waterbodies Workgroup identified nine recommendations to improve pollution prevention in the Plan area, including reforming land and water management practices, restoring and protecting riparian areas, identifying and monitoring abandoned mines, controlling invasive aquatic species, and monitoring marinas and recreational facilities for impacts to water quality (Table 6-1).

6.2.5.5 Salt and Salinity Management

Salt and salinity management is the control of salts (including dissolved minerals such as lime, gypsum, and other slowly dissolved soil minerals) and salinity. Human causes of salinity include use of home water softeners, concentration of salts from treated water processes, and the use of fertilizers or soil amendments. The most common ions found in water are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and nitrate. Salt is present to some degree in all natural water supplies because soluble salts in rocks and soil begin to dissolve as soon as water reaches them.

Salinity management not only reduces salt loads that affect a region, it is also a key component of securing, maintaining, and recovering usable water supplies. Salt is ubiquitous throughout the environment and it is a conservative constituent – meaning it is never destroyed, only concentrated or diluted and transported. Since salts are ubiquitous, any water use and reuse increases salinity as each use subjects the water to evaporation. If reused water passes through soil, additional dissolved salts will be picked up. The continued concentration of salt is a major element of any recycled water project. Salts may accumulate in water conveyance and treatment facilities and must be removed at substantial cost to the operator.

Salt management involves source control, treatment, and dilution. Source control means limiting the initial concentration of salts through minimizing artificial inputs such as agricultural chemicals or using naturally less saline source water. Treatment refers to mechanical removal of salts with membrane filters or distillation, and is expensive, energy-intensive, and produces highly concentrated end products that must be stored or transported. Dilution is mixing low-salinity water with saline water to reduce the total concentration of salts. Real-time salinity management employs a form of dilution, timing the release of saline waters into a river with periods of high natural flow in order to keep salinity levels below thresholds for beneficial uses downstream. Salinity management issues are more prominent in coastal or arid regions, and in agricultural areas such as the Central Valley, than in upper watershed regions such as the Upper Feather River watershed; however, soils in Sierra Valley are considered highly saline due to high electrical conductivity⁴.

The local benefits of sustainable salinity management include restoring and maintaining beneficial uses of water within the basin, securing and improving the reliability of the water supply, and enhancing local economic stability by providing reliable drinking water sources and water quality that supports local industries. The Municipal Services Workgroup identified two recommendations for salinity management in the region, including treatment and real-time salinity management (Table 6-1).

6.2.5.6 Urban Stormwater Runoff Management

Urban stormwater runoff management describes a broad range of activities to manage both stormwater and dry-weather runoff. Dry-weather runoff occurs when water flows to the storm drain because of activities such as excessive landscape irrigation, car washing, and other urban outdoor water uses. Urbanization alters flow pathways, water storage, pollutant levels, rates of evaporation, groundwater recharge, surface runoff, the timing and extent of flooding, the sediment yield of rivers, and the suitability and viability of aquatic habitats.

Urbanization creates impervious surfaces that collect pollutants that are washed off to surface waters during rain events. The impervious surfaces also increase runoff volumes and velocities, resulting in streambank erosion, and potential flooding downstream. Because of the emphasis on removing the water quickly, the opportunity to use storm-generated runoff for multiple benefits is reduced. Traditionally, urban stormwater runoff management was viewed as a response to flood control concerns resulting from the effects of urbanization; however, concerns about the water quality impacts of urban runoff have led water agencies to look at watershed approaches to control runoff and provide other benefits. As a result, urban stormwater runoff management is now linked to other resource management strategies.

A watershed approach for urban stormwater runoff management seeks to emulate and preserve the natural hydrologic cycle that is altered by urbanization. The watershed approach consists of best management practices (BMPs) designed to reduce the pollutant loading and reduce the volumes and velocities of urban runoff discharged to surface waters. Common BMPs include facilities to capture, treat, and recharge groundwater with urban runoff; public education campaigns to inform the public about stormwater pollution, including the proper use and disposal of household chemicals; and technical assistance and stormwater pollution prevention training. There are no stormwater management plans in the region.

The primary benefits of urban stormwater runoff management are to reduce surface water pollution and improve flood protection. Additional benefits include increasing water supply through groundwater

⁴ Department of Water Resources, 2013. *California Water Plan Update 2013, Table 19-3*. Available at: http://www.waterplan.water.ca.gov/docs/cwpu2013/Final/Vol3_Ch19_SaltSalinity-Mgmt.pdf.

recharge and reduced pollution. Groundwater recharge and stormwater retention sites can also be designed to provide additional benefits to wildlife habitat, parks, and open space. The general absence of urbanization in the Plan area reduces the potential for urban stormwater runoff issues; however, localized effects on water quality can still result from runoff. Although the scale of urban stormwater may be limited in the Plan area, low precipitation as a result of climate change may amplify pollutant buildup, creating an imperative to develop BMPs for pollutant load reduction.

The Municipal Services Workgroup identified five recommendations to improve urban stormwater runoff management in the region, including education and public outreach, coordination among stakeholders in stormwater management policies, and providing incentives for low-impact design features on new development and retrofitting of existing development (Table 6-1).

6.2.6 Practice Resource Stewardship

Integrated and sustainable water management must take into account the fact that water resources originate in upland areas. Uplands are the vast majority of the catchment area for precipitation, and nearly all surface water has passed over, under, or through upland soils before reaching a stream, wetland, or waterbody. The health of forested uplands, agricultural lands, meadows, floodplains, and groundwater recharge areas is essential to maintaining the quality and reliability of surface and groundwater supplies. In addition, all life depends on water, and a healthy natural environment contributes to human well-being through the providing of ecosystem services such as crop pollination, waste decomposition, carbon sequestration, air and water purification, and recreation. Appropriate stewardship of all the lands and resources in a watershed is integral to the management of water resources.

6.2.6.1 Agricultural Land Stewardship

Agricultural land stewardship refers to private farm and ranch landowners producing public environmental benefits (conservation of natural resources and protection of the environment) in conjunction with the food and fiber they have historically provided. Land managers practice agricultural land stewardship by conserving and improving land for food, fiber, biofuel production, watershed functions, and soil, air, energy, plants, animals, and other conservation purposes. Agricultural land stewardship also protects open space and the traditional characteristics of rural communities. Agricultural land stewardship practices can protect the health of environmentally sensitive land, recharge groundwater, improve water quality, provide water for wetland protection and restoration, reduce costs of flood management, and aid riparian restoration and management projects. Land can also be managed to improve water management, stormwater runoff control, water storage, conveyance, and groundwater recharge. Such stewardship practices are particularly advantageous as they do not rely on construction of major facilities and provide a range of environmental co-benefits.



Creek fencing and livestock crossing (Source: UFWG)

The Agricultural Lands Stewardship Workgroup identified 17 recommendations to promote agricultural land stewardship in the region, including improved funding, education, and outreach for promoting stewardship practices implementation, infrastructure development, program monitoring, information sharing, agency planning, conservation easements, stream restoration, water storage, vegetation

management, carbon sequestration, and enhancing local appreciation for the importance of agricultural working landscapes (Table 6-1).

6.2.6.2 Ecosystem Restoration

Ecosystem restoration describes the improvement of modified natural landscapes and biological communities to provide for their sustainability and for their use and enjoyment by current and future generations. It is anticipated that increased temperatures and other climate change impacts will degrade ecosystem health. Restoration for past ailments and projected problems will strengthen the ecosystem and help species adapt to climate change impacts.

Few, if any, modified ecosystems can be fully restored to their pre-development condition. Instead, efforts focus on rehabilitation of important elements of ecosystem structure and function. Successful restoration increases the diversity of native species and biological communities and the abundance of habitats and connections between them. This can include reproducing natural flows in streams and rivers, curtailing the discharge of waste and toxic contaminants into water bodies, controlling non-native invasive plant and animal species, removing barriers to fish migration in rivers and streams, and recovering wetlands so that they can store floodwater, recharge aquifers, filter pollutants, and provide habitat.

Rivers and their associated floodplain ecosystems provide numerous benefits that can be thought of as goods and services. These include water purification, groundwater recharge, erosion control, storage of floodwaters, hydropower generation, soil-building, pollination, wood products, carbon sequestration, fisheries, wildlife, and recreation. The most significant ecosystem restoration issues in the region are restoration of healthy forest stands and degraded meadows. Other issues include sedimentation in streams, invasive species, and loss of fisheries habitat and fish populations. The modification of the region's rivers by dams is a significant change to natural systems.

The Floodplains, Meadows, and Waterbodies Workgroup identified ten recommendations to promote ecosystem restoration in the watershed, including protecting streams and source waters from pollution; restoring natural stream flows and hydroperiods; restoring natural sediment transport regimes; removing barriers to the movement of fish and other aquatic organisms; establishing biological reserves and ensuring connectivity among habitat patches; and controlling invasive species (Table 6-1). The Uplands and Forests Workgroup identified 13 recommendations for promoting ecosystem restoration in the Plan area, including restoring and connecting habitats, protecting against catastrophic wildfire, restoring healthy forest stand densities, controlling invasive species, restoring and protecting source surface and groundwater (Table 6-1).

6.2.6.3 Forest Management

Forest management is the application of forestry principles, practices, and business techniques to the management of forested lands to achieve the owner's objectives. Different forest landowners have different goals and objectives and different strategies to accomplish them; however, the water produced by these forests has economic value that equals or exceeds that of any other forest resource. Forest management activities can affect water quantity and quality. For purposes of water management, this strategy focuses on forest management activities on both public- and privately-owned forest lands for the conservation of forest ecology and productivity, including favorable flows of water that originate from forestlands.

The vast majority of forested lands in the region are managed by the U.S. Forest Service, mostly in Plumas National Forest, but also including parts of Tahoe and Lassen National Forests. National Forests were established under the Organic Act of 1897, which specifically states that a primary purpose of these lands

is to “secure favorable conditions of water flow.” Direct management of these forested lands is the responsibility of the USFS, and implementation of resource management strategies under this Plan will depend on the management plans of that agency. Forest management issues in the watershed that affect water supply and quality include increased sedimentation caused by erosion from poorly maintained roads and areas burned by fires; reduced water retention caused by either loss of canopy from catastrophic fire or from unnaturally high stand densities due to fire suppression and lack of biomass utilization facilities ; conversion of forest to brush following fires; and pollution from abandoned mine sites and other past land uses on public lands now managed by the USFS. Private forest owners include W. M. Beaty and Associates, Soper-Wheeler Company, Collins Pine Company, and Sierra Pacific Industries.

Rising temperatures and longer dry seasons, both of which are expected in the Upper Feather River (UFR) watershed because of climate change, increase the risk of wildfire. Rising temperatures and earlier snowmelt are shown to increase the frequency, size, and severity of wildfires, trends that align with wildfire activity in the Sierra Nevada since the early 1980s. In addition to the increased risk of wildfires from higher temperatures and ongoing drought, increasing fuel supply exacerbates the risk. As rains replace winter snows due to rising temperatures, plant growth is expected to accelerate, increasing moisture competition and stress in living trees and increasing dead and ladder fuel flammability for wildfires. Catastrophic wildfire removes vegetative cover and reduces the stability of soils, increasing erosion rates and runoff for months to decades. If a heavy rain event occurs after a fire, soil, ash, and sediment can flow into surface waters in the UFR watershed, degrading water quality. Climate projections estimate that when precipitation does occur, it will be in the form of heavy rains, increasing the volume of water to carry sediment over burned areas into streams and waterbodies. Managing forests through strategic fuel reduction and forest management can help protect the watershed’s ecosystem and promote high water quality.

The Uplands and Forests Workgroup identified three recommendations for forest management in the Plan area: 1) integrated research and implementation projects to assess the effects of a wide range of forest management practices and watershed trends in the region, 2) monitoring, modeling, and studies to assess the effects of climate change, and 3) study the effect of increasing forest densification for forest health and surface water and groundwater conditions. (Table 6-1). The Tribal Advisory Committee (TAC) identified four recommendations for forest management in the region, including restoring natural fire regimes, and employing traditional ecological knowledge (TEK) in collaborative studies and projects to restore water quality and control the spread of invasive species (Table 6-1).

6.2.6.4 Land Use Planning Management

Land use planning is the orderly and planned use of land, resources, facilities and services with a view to securing the physical, economic and social sustainability, health, and well-being of urban and rural communities. Stronger collaboration between land use planners and water managers can promote more sustainable and efficient land-use patterns and integrated regional water management practices, which can produce safer and more resilient communities. Integrating land use and water management consists of planning for the housing and economic development needs of a growing population, while providing for the efficient use of water, water quality, energy, and other resources. Land use decisions can also help reduce greenhouse gas (GHG) emissions, which contribute to climate change, by encouraging alternative modes of transportation (such as walking and biking) and green building (which reduces a home or building’s energy use). Land Use Planning and Management RMS emphasize strategies to promote compact and sustainable urban and rural development.

While the region is projected to experience a slight decline in population through 2030, the on-going shift in the regional economic base toward tourism, seasonal residents, services, and health care will still drive

new development (see Section 3.3 for a discussion of demographic and economic trends in the Plan area). All four workgroups identified recommendations for land use planning, including planning for compact and sustainable development; directing development away from wetlands, meadows, and recharge areas; improved communication among land use planners, water managers, and agencies; and agriculture-supportive goals and strategies in county land use plans (Table 6-1).

6.2.6.5 Recharge Area Protection

Recharge areas are those areas that provide the primary means of replenishing groundwater. Good natural recharge areas are those where high-quality surface water is able to percolate through the sediments and rocks to the saturated zone that contains groundwater. If recharge areas cease to function properly, there may not be sufficient groundwater for storage or use. Protection of recharge areas is necessary to maintain the quantity and quality of groundwater in the aquifer; however, protecting recharge areas by itself does not provide a supply of water. Recharge areas are functioning properly when aquifer storage capacity is available, sufficient permeable surface is present, and an adequate supply of high-quality water to recharge the aquifer is available.

Because of its location in the upper watershed, adequate supply of high-quality surface water is generally not an issue in most of the region. Rather, the principal issues of groundwater recharge in the watershed are reduced infiltration and retention of surface water in forested uplands, loss of wetland functions in meadows, and the shift in precipitation from snow to rain. The Floodplains, Meadows, and Waterbodies Workgroup identified several recommendations for recharge area protection in the region, including identifying actual and potential recharge areas, protecting and restoring meadows (Table 6-1).

6.2.6.6 Sediment Management

Sediment management refers to the management of fine solid fragmented material such as silt, sand, and clay, which is suspended in or settled on the bottom of a water body. Like water, sediment is a valuable resource and is vital to the functioning of beaches, wetlands, spawning beds, and riparian habitat. Sediment deposited by floodwaters is also a source of fertile agricultural soils. However, excessive sediment can lead to clouded water, degraded wildlife habitat, barriers to navigation, and decreased storage capacity in reservoirs, among other things.

Source management is preventing soil loss and adverse sediment flows from land use activities that may, without proper management, cause erosion and excessive sediment movement. Routine source management activities prevent or mitigate excessive sediment introduced into waterways due to recreational use, roads and trails, grazing, farming, forestry, and construction. Erosion of uplands caused by roads and fires, along with erosion and incision of stream channels in meadows, causes excess sedimentation in streams and reservoirs in the watershed. The impacts of climate change may also create need for increased sediment management, as more intense, severe storms may lead to increased erosion and turbidity in surface waters.

The Agricultural Lands Stewardship Workgroup identified six recommendations to improve sediment management in the region, including education and outreach, evaluation and management of sediment sources such as roads and burned areas, evaluation of agricultural water delivery infrastructure for sediment management needs, and re-use of sediment removed during mitigation for beneficial uses such as wetland restoration and agriculture (Table 6-1). The Uplands and Forests Workgroup identified four recommendations to improve sediment management in the region, focused on coordination of state and federal agency regulations and practices and on post fire recovery. (Table 6-1).

6.2.6.7 Watershed Management

Watershed management is the process of creating and implementing plans, programs, projects, and activities to restore, sustain, and enhance watershed functions. These functions provide the goods, services, and values desired by the human community that are affected by conditions within a watershed. A primary objective of watershed management is to increase and sustain a watershed's ability to provide for the diverse needs of the communities that depend on it including local, regional, state, federal, and tribal stakeholders. Watershed management initiatives should work to blend community goals and interests with the broader goals of the state as a whole in a manner consistent with improving environmental, social, institutional, and economic conditions within the watershed. The need to incorporate environmental justice and social equity should also be recognized and addressed, along with more traditional project management approaches.

The Floodplains, Meadows, and Waterbodies Workgroup identified 16 recommendations to promote watershed management in the region, including improving the scientific basis of projects and of monitoring programs that track changes and disseminate information to stakeholders, preserving and restoring habitats, species, and soils, and improving coordination and information sharing among stakeholders (Table 6-1). The Uplands and Forests Workgroup identified ten recommendations to promote watershed management in the region including integrating traditional ecological knowledge into monitoring and project assessment, improving interagency cooperation, involving federal agencies as partners in grant programs, allowing federal funds and in-kind services to be used as matching funds, and developing science-based projects to accomplish landscape-scale ecosystem restoration (Table 6-1).

6.2.7 People and Water

Water management is a human activity, undertaken because people have an unbreakable relationship to, and dependence on, water. Essentially all water management infrastructure exists to provide water to people for out of stream uses. In-stream environmental water uses affect people through human cultural, spiritual, economic, and aesthetic relationships to water and the natural systems it supports. Encouraging conservation, efficient use, and protection of water resources among the public can have positive effects on all other aspects of water management. Recognizing the need to incorporate the relationships between people and water is important to effective and sustainable water management.



Kayaker on Frenchman Lake (Courtesy of Kristi Jamason)

6.2.7.1 Economic Incentives

Economic incentives include financial assistance, water pricing, and water market policies intended to influence water management. Economic incentives can influence the amount and timing of water use, the source of supply, and the volume of wastewater produced. State grant programs help fund planning and infrastructure projects designed to enhance water use efficiency, as well as subsidies for services to disadvantaged communities. Most urban water suppliers in California are moving toward tiered rate structures in which the unit water charge increases as water use increases. Policies that facilitate water transfers and water banking among agencies increase resiliency to drought and improve efficiency. Economic incentives to support sustainable water management can help protect water supplies that will become increasingly vulnerable because of climate change impacts. Additionally, reductions in water lead

to reductions in energy use that would have previously been needed to process the water, thereby reducing greenhouse gas emissions.

The Municipal Services Workgroup identified three recommendations for utilizing economic incentives in the region: regular review and adjustment of water rates and using tiered rate structures, and adopting policies that promote long-term water use efficiency (Table 6-1). The Uplands and Forests Workgroup identified four recommendations for utilizing economic incentives in the region: reducing barriers and liabilities to managed burning, developing programs that support biomass utilization, groundwater recharge, and catastrophic fire reduction, managed fire reintroduction, integrating traditional ecological knowledge into program implementation and evaluation, and improving capacity of local stakeholders to carry out RMS implementation (Table 6-1).

6.2.7.2 Outreach and Engagement

Outreach and engagement describe the use of public communication tools and practices by water agencies to encourage public groups and individuals to contribute to positive water management outcomes. Public outreach and engagement produce two broad types of benefits: instrumental, outcome-oriented benefits (such as designing a program that satisfies multiple criteria) and intrinsic, process-oriented benefits (such as building trust between participants). Public involvement leads to instrumental outcomes in two ways. First, public involvement results in a citizenry that is more understanding and appreciative of the issue, and thus one that makes informed decisions. Second, public involvement assists agencies in making better decisions as a direct result of including public knowledge. In addition to instrumental outcomes, public involvement provides many intrinsic benefits, such as enhanced community capital. Outreach and engagement that incorporates lessons about the impacts of climate change can help create a more prepared community and encourage residents to engage and support activities that reduce GHG. Outreach and engagement efforts range from informing and educating to empowering, and the tools used mirror the goals of engagement.

The Agricultural Lands Stewardship Workgroup identified eight recommendations to improve public outreach and engagement for water management in the region that include using varied media for outreach and engagement; making data and agency contact information available to the public; using project-specific education and outreach as well as established programs; and training managers and board members of local agencies and organizations how to engage the public (Table 6-1). The Uplands and Forests Workgroup identified three recommendations to improve public outreach and engagement for water management in the region: incorporating outreach and education into project implementation, expanding existing education programs, and working with adjacent and downstream landowners to improve understanding of benefits that result from large scale and coordinated watershed projects (Table 6-1).

6.2.7.3 Water and Culture

Incorporating culture into water management increases awareness of how cultural values, uses, and practices are affected by water management, and how they affect water management. Water and water-dependent resources shape individual and collective experiences that contribute to individual and community well-being, sense of identity, and connection with the natural world. These experiences are inextricably linked to values, traditions, and lifestyles, which in turn inform perspectives and expectations regarding water resources and conditions. Understanding these connections, and how these relationships may change because of climate change, can help communities prepare for impacts and protect or adapt cultural values. Cultural considerations by their nature are inherently linked to every resource

management strategy. Expression of cultural connections to water and water-dependent resources can involve a wide range of activities and material objects.

The Tribal Advisory Committee identified two recommendations for incorporating cultural considerations into water management in the region: recognizing as beneficial uses those that support the cultural, spiritual and traditional lifeways of California Indian Tribes, Tribal communities and families, and integrating and applying TEK in collaboration with Tribes, Tribal organizations, and cultural traditional ecological practitioners (Table 6-1).

6.2.7.4 Water-dependent Recreation

Water-dependent recreation describes recreation activities in or on water, including fishing, swimming, skiing and snowboarding, waterfowl hunting, motor boating, wind surfing, kayaking, and passive recreation activities that can be enhanced by water, such as wildlife viewing (including birding), picnicking, biking, relaxing on the beach, camping, and hiking. The right of public access to navigable waterways, lakes, and beaches is protected by a variety of federal, state, and regional laws. Agencies such as the Federal Energy Regulatory Commission and the State Water Project are required by law to consider recreation in their decisions and projects. As resource extraction industries decline, the economy of the region is trending more heavily toward tourism and recreation, most of which is water-oriented. As winter snows and summer runoff are expected to diminish as climate change worsens, recreation that depends on healthy streams (such as birding and fishing) or high water levels (such as boating and swimming) is increasingly at risk. This has potential for impacts in the tourism and recreation sectors of the regional economy.

The Floodplains, Meadows and Waterbodies Workgroup identified 11 recommendations for water-based recreation in the watershed, including identifying recreational and educational opportunities in the region; reducing impacts from water recreation; restoring water quality, fish populations, and riparian systems in the region; and educating residents and businesses in the watershed about their role in protecting water quality and recreational opportunities (Table 6-1).

6.2.8 Other Strategies

Other strategies are management strategies that can potentially generate benefits that meet one or more water management objective(s), but have limited capacity to strategically address long-term regional water planning needs. These are unique or uncertain strategies that do not fit into the framework of the RMSs discussed previously. Some have only local or specific application, and others rely on unpredictable conditions.

6.2.8.1 Miscellaneous

The Agricultural Lands Stewardship Workgroup identified three strategies not included in other RMSs that would further the goals and objectives of the IRWM Plan:

1. **Windbreaks and snow fences:** Snow fences slow the velocity of wind, which cause the deposition of snow downwind of the fence. Snow fences do not increase the total amount of snow that falls, but they concentrate snowfall in small local areas (1.25 acres or less), creating deeper snow pack in some places and shallower or no snow pack in others. Deeper snow pack melts more slowly, which extends the release of winter precipitation farther into the summer dry season.

2. Reestablish historic wetlands: Where possible, wetlands that have been converted to other uses or lost to stream erosion could be restored to increase water retention, improve water quality, and enhance wildlife habitat.
3. Rainfed agriculture: Rainfall in real time provides all crop consumptive water use directly. Owing to the unpredictability of rainfall frequency, duration, and amount, there is significant uncertainty and risk in relying solely on rainfed agriculture. This is especially true in California, where there is little or no precipitation during most of the spring and summer growing season. Rainfed agriculture is successful in parts of California where winter wheat is cultivated without irrigation, producing extra crop yield that can replace a portion of summer yield lost to reduced irrigation. The cold winters and low precipitation of agricultural areas in the region make rainfed agriculture an uncertain strategy, but one that still merits study.

The Uplands and Forests Workgroup identified nine strategies for forest and fuels management not included in other RMSs:

1. Reduce risk of wildfire through strategically located fire breaks for ridgeline lightning, roadway, and railroad ignitions,
2. Forest and fuels management for protection of critical habitats.
3. Snow zone fuels and fire management.
4. Wildfire liability reduction.
5. Wildland-Urban Interface (WUI) fuels management.
6. Traditional Ecological Knowledge (TEK) to reintroduce historic fire regimes.
7. Community recharge area management to protect domestic and agricultural wells from catastrophic wildfire and from reduced groundwater infiltration or excessive siltation.
8. All-scale biomass utilization including community and tribal biomass projects.
9. Landscape-scale forest and fuels management that includes multiple (#1-#8) fire and fuels management strategies.

6.2.8.2 Wastewater/NPDES

The Municipal Services Workgroup added the wastewater and NPDES permitting management strategy and identified five recommendations to improve wastewater management facilities and administrative/operator capacity in the region:

1. Water and wastewater treatment as a resource management strategy potentially includes integration of agricultural and domestic wastewater into the water supply equation. Water/wastewater treatment has been a significant issue for several decades.
 - Regional facilities to treat wastewater to a level necessary for recycled or potable use.
 - Water/wastewater treatment as a supply option through groundwater recharge and/or other means.

2. Aging wastewater infrastructure and the need for upgrades to meet new and revised state standards. This strategy will also be important when considering water-recycling opportunities. Actions might include:
 - Facility upgrades.
 - Assessment of private sewage treatment for safety next to wells in areas of semi-dense development (one-acre plots).
 - Development of strategies for wastewater treatment to ensure the maintenance of receiving water quality.
3. Infrastructure reliability: recognizes the importance of maintaining and upgrading infrastructure for water supply, treatment, and distribution; wastewater collection, treatment, and disposal; and recycled water treatment and distribution. Infrastructure improvements are continually needed as facilities age, demands on their use increase (due to population growth, degraded water quality, or increased water quality standards), and new technologies are introduced.
4. Provide training in wastewater collection, treatment, and disposal that will increase the certified operational pool in the region (succession planning).
5. Increase public outreach activities to promote the water and wastewater fields as career paths.

6.3 Strategies not Applicable to the Upper Feather River Region

The following RMSs from the *California Water Plan Update 2013* were considered but not included in the UFR IRWM Plan because they are not applicable to the Upper Feather River region.

6.3.1.1 Conveyance – Delta

The State of California is developing a large-scale plan for conveyance of water through the Sacramento-San Joaquin Delta, which is the confluence point of the Sacramento and San Joaquin Rivers that drains to the Pacific Ocean. The purpose of the state plan is to promote coequal goals of protecting the Delta ecosystem and maintaining a stable supply of water for California. While the Upper Feather River region is a major contributor of water to the State Water Project, water from the Plan area reaches the Delta through the Lower Feather River and Sacramento River, which are outside the IRWM region.

6.3.1.2 Desalination

Desalination involves removal of salts from brackish and saline water through various technologies. The UFR Region does not include any coastal or other saline waters.

6.3.1.3 Surface Storage – CALFED/State

CALFED is a joint federal-state effort created to coordinate activities in the Sacramento-San Joaquin Delta. The state and federal governments have funded investigations into five sites for surface storage that would meet the goals of water supply reliability, water quality, and ecosystem restoration. None of these five sites is in the UFR Region.

6.4 Strategy Recommendations

6.4.1 Process

In April 2015, the RWMG reviewed and discussed the RMS, removing those not relevant to the region and requesting that workgroups select RMSs for which they would be responsible. In May, the RWMG assigned the remaining applicable RMSs to workgroups to ensure each applicable RMS was addressed. Additionally, in May 2015, Tribal representatives volunteered to develop recommendations for several of the RMSs, primarily those related to water and culture.

Each of the workgroups used a collaborative process to develop recommendations for their assigned RMS, considering the strategy recommendations identified in the *California Water Plan 2013 Update* and those identified by other IRWM regions. The RMS recommendations were thoroughly reviewed and vetted by workgroup participants and presented to the RWMG at public meetings in November 2015 and January 2016.

6.4.2 Matrix of Recommendations

Table 6-1 provides a matrix of the recommendations each Workgroup identified for the 27 Standard RMSs applicable to the UFR Region. These strategy recommendations are tailored to the specific goals and objectives of the IRWM Plan (see Appendix 6-1 for identified linkages between RMS recommendations and Plan objectives). A blue dot ● indicates that the Workgroup strategy recommendation is supportive of climate change adaptation or GHG efforts.

Table 6-1. Summary of Workgroup Recommendations for Resource Management Strategies

#	RMS	Workgroup of Origin	Workgroup Strategy Recommendations
Objective: Reduce Water Demand			
1	Agricultural Water Use Efficiency	Agricultural Land Stewardship	<p>Education, Data and other Technical Assistance:</p> <ul style="list-style-type: none"> ● 1. Explore and identify techniques to improve overall agricultural water use efficiency. ● 2. Expand water efficiency information, evaluation programs and on-site technical assistance reaching water suppliers, farmers and ranchers, through academic institutions, including agricultural extension services, Resource Conservation Districts (RCD), independent crop advisors, and other agricultural outreach efforts. ● 3. Agricultural, water and environmental stakeholders develop community educational and motivational strategies for conservation activities to foster water use efficiency. 4. RCDs and groundwater districts in agricultural areas collect--and UC Cooperative Extension and Plumas-Sierra Agriculture Departments document--promising practices and plans for droughts and other water shortages. ● 5. Develop sources of real-time data to provide irrigators and water managers with better information with which to make water management/irrigation decisions, such as: <ul style="list-style-type: none"> a. Local meteorological/weather data b. Soil moisture data (meters) c. Water application/use monitoring d. Surface water depth and flow data e. Surface to groundwater depth f. Groundwater modeling ● 6. Develop methods to quantify and communicate water savings and costs associated with hardware upgrades, water management, and evapotranspiration reduction projects. 7. Develop consistent, watershed-wide methodology for collecting and reporting water use information by users and suppliers (groundwater and surface) that is consistent with state requirements. ● 8. Develop comprehensive educational, informational, and awareness efforts regarding sustainability of consumption of local products in the water-use efficiency programs for growers, water suppliers, post-harvesting processors, consumers, and others. Encourage reducing long-distance commodities transporting and importing commodities and thus, reduce energy use and greenhouse gas emissions. <p>Use of Promising Practices:</p> <ul style="list-style-type: none"> ● 9. Steward soil and wetland areas for increased groundwater holding and recharge, as well as sediment management. ● 10. Employ flood management capacities of agricultural land to support groundwater recharge, reduce

#	RMS	Workgroup of Origin	Workgroup Strategy Recommendations
			<p>infrastructure damage, control erosion and sedimentation of waterways and improve downstream water quality:</p> <ol style="list-style-type: none"> a. Explore diversion of flood/high season water to aboveground storage areas b. Employ flood easements to compensate farmers/ranchers who allow fields to be flooded during extreme events <ul style="list-style-type: none"> ● 11. Utilize conservation easements and proven (or promising) practices to protect water supplies and water quality. ● 12. Adjust irrigation schedules and methods to decrease the amount of water used or applied, including possible use of low energy precision application (LEPA) for center pivots. ● 13. Provide help to convert to more drought-resistant or less-water-consumptive cropping. ● 14. Identify appropriate water efficiency methods, encourage pilot/demonstration projects, track water efficiency measures and resulting savings—publicly available, consolidated at regional level, e.g., by Valley (Indian Valley, American Valley, Sierra Valley, Mountain Meadows)—to preserve privacy. ● 15. Facilitate use of available recycled water that otherwise would not be used beneficially, e.g., use of treated wastewater from mills, treatment plants, etc. for irrigated pasture; widespread use of graywater. ● 16. Implement source water protection measures.
2	Urban Water Use Efficiency	Municipal Services	<ul style="list-style-type: none"> ● 1. Implement programs such as best management practices. ● 2. Provide information to homeowners regarding water efficient landscapes. 3. Increase public outreach and encourage community involvement. 4. Fund incentive programs for small districts and disadvantaged communities (DAC). ● 5. Conduct large landscape surveys and develop water efficient landscape guidelines. 6. Conduct audits of internal water distribution systems. ● 7. Identify excessive water users and offer water audits.
Objective: Improve Flood Management			
3	Flood Management	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> ● 1. Restore floodplain function to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and release floodwaters.
Objective: Improve Operational Efficiency and Transfers			
5	Conveyance - Regional/Local	Agricultural Land Stewardship	<ul style="list-style-type: none"> ● 1. Improve aging infrastructure, increase existing capacities, and/or add new conveyance facilities. 2. Add fish ladders and state-of-the-art fish screens to conveyance structures. ● 3. Establish a baseline hydrology and enhanced description of present water management system components. ● 4. Replace or improve canal structures to improve the ability of irrigation districts, water companies and

#	RMS	Workgroup of Origin	Workgroup Strategy Recommendations
			<p>other entities to manage and control water in the region and reduce spillage.</p> <ul style="list-style-type: none"> ● 5. Control invasive weeds to improve flow, reduce spread of weeds, and reduce sedimentation and bank erosion/degradation. ● 6. Evaluate conveyance infrastructure for risk from earthquake and flood, and the role it could play in flood control. Plan for needed improvements.
6	System Reoperation	Municipal Services	<ul style="list-style-type: none"> 1. Collaborate with federal, state, and local agencies on system reoperation studies. 2. Perform system audits to identify operational improvements that can be made. ● 3. Encourage conjunctive management.
7	Water Transfers	Municipal Services	<ul style="list-style-type: none"> ● 1. Develop and implement groundwater management plans, monitoring programs. 2. Assemble data from existing monitoring programs and analyze them in an effort to identify additional areas to monitor. ● 3. Consider inter-, intra-, and interstate basin transfers to maximize water use.
Objective: Increase Water Supply			
8	Conjunctive Management	Agricultural Land Stewardship	<ul style="list-style-type: none"> ● 1. Assess the connection between groundwater, spring and surface water sources and recharge areas to better understand their interactions. ● 2. Identify tools and data sharing needed to improve surface, groundwater and conjunctive water management: <ul style="list-style-type: none"> a. Develop and make available to the public a consolidated map of groundwater basins, recharge areas, California Statewide Groundwater Elevation Monitoring (CASGEM) wells, state websites (e.g., Groundwater Ambient Monitoring and Assessment Program [GAMA]) and data for all groundwater basins in the UFR watershed b. Regular monitoring of surface and groundwater levels and quality throughout watershed with publicly accessible data: <ul style="list-style-type: none"> ○ Hydrogeologic characterization of the aquifers ○ Changes in groundwater levels ○ Groundwater flow (inter-basin + to/from streams) ○ Groundwater quality ○ Land subsidence, if any ○ Surface water flow ○ Surface water quality ○ Interaction of surface and groundwater

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			<ul style="list-style-type: none"> ● 3. Implement a program to promote public education about groundwater and its relation to surface water, including: <ul style="list-style-type: none"> a. Interconnection of surface water and groundwater b. Benefits of recharging groundwater with surface water and recycled water c. Importance of protecting groundwater quality and recharge areas d. Seasonal versus long-term changes in groundwater levels e. Potential impacts of climate change on groundwater resources f. Organizations with management responsibility: obtain contact info, responsibilities, etc. g. Data sources ● 4. Coordinate surface and groundwater management where local agencies overlap geography. ● 5. Preparation and execution of sustainable groundwater management plans for all groundwater basins (not just Sierra Valley), that protect groundwater elevation and quality, surface water-groundwater interaction and groundwater ecosystem services. ● 6. Increase local and regional groundwater recharge and storage to reduce groundwater depletion. 7. Monitor and possibly execute on developments if/when SWRCB creates "measures whereby agencies proposing to use peak surface water flow for groundwater recharge are not subject to potential protest of their existing water right, in order to stipulate groundwater recharge as a reasonable beneficial use of their surface water right." ● 8. Improve and repair infrastructure that supports the conjunctive use of surface and groundwater. ● 9. Explore, map, and conduct overall evaluation of potential for groundwater banking.
		Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> 1. Implement monitoring, assessment, and maintenance of baseline groundwater levels. ● 2. Encourage local water management agencies to coordinate with tribes and other agencies involved in activities that might affect long term sustainability of water supply and water quality. ● 3. Local groundwater monitoring and management activities and feasibility studies to increase the coordinated use of groundwater and surface water. ● 4. Restore wet meadows to full biological function to enhance storage and more continuous release of shallow groundwater. ● 5. Implement a program to promote public education about groundwater and surface water connectivity.
10	Precipitation Enhancement	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> ● 1. Collect data and evaluate existing California precipitation enhancement projects within the UFR Region on their effectiveness and impact on water quality and human health. 2. Collaborate with academic institutions, agencies, and local citizen groups on research.

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11	Municipal Recycled Water	Municipal Services	<ul style="list-style-type: none"> 1. Increase funding availability for water reuse/recycling facilities and infrastructure. 2. Create education curriculum for public schools and institutions of higher learning to educate the public about recycled water. 3. Engage the public in an active dialogue and encourage participation in the planning process of water recycling projects including non-potable and potable applications. 4. Provide resources (i.e. funding) to agencies that will perform comprehensive analyses of existing water recycling projects to estimate costs, benefits, and water deliveries. 5. Assess water recycling technology to determine least costly and environmentally appropriate technology based on location and need.
13	Surface Storage - Regional/Local	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> 1. Increase surface storage and timed releases for agricultural and natural resource purposes. 2. Increase water-holding capacity of riparian vegetation and wetlands. 3. Develop a comprehensive methodology for analyzing project benefits and costs by local agencies. 4. Continue studies, research, and dialogue to identify a common set of tools for determining costs and benefits of local surface storage projects, and assess need for determining need for future projects.
Objective: Improve Water Quality			
14	Drinking Water Treatment and Distribution	Municipal Services	<ul style="list-style-type: none"> 1. Develop incentives to allow water systems to reduce waste of limited water resources. 2. Provide additional funding for water supply, water treatment, and infrastructure projects to ensure safe and reliable supply of drinking water for individuals and communities. 3. Improve treatment facilities to include more sophisticated methods of treatment such as membrane filtration, ultraviolet light, and ozonation. 4. Upgrade aging water storage and distribution systems, which may have an impact on water quality that pose public health risks. 5. Improve water system to prevent cross connections and backflow in distribution systems.
15	Groundwater Remediation/ Aquifer Remediation	Municipal Services	<ul style="list-style-type: none"> 1. Implement source water protection measures. 2. Establish and supporting funding for detecting emerging contaminants by commercial laboratories and installation of wellhead treatment systems. 3. Treat contaminated groundwater while it is still in the aquifer (in situ). 4. Extract contaminated groundwater from the aquifer and treating it outside of the aquifer (ex situ).
16	Matching Water Quality to Use		<ul style="list-style-type: none"> 1. It may be possible in the region to allocate effluent for in-stream use. 2. It may be appropriate that water used in industrial processes, such as in timber mills, could be of non-potable quality in order to preserve potable water for human consumption.

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			<ol style="list-style-type: none"> 3. Manage water supplies to optimize and match water quality to the highest possible use and to the appropriate technology. 4. Encourage upstream users to minimize the impacts of nonpoint urban and agricultural runoff and treated wastewater discharges. 5. Review projects to determine the potential impacts from wastewater elimination into local streams. 6. Support research into solutions to the potential conflicts between ecosystem restoration projects and the quality of water for drinking water purposes.
17	Pollution Prevention	Agricultural Land Stewardship	<ol style="list-style-type: none"> 1. Regional, tribal, and local governments and agencies should establish drinking water source and wellhead protection programs to shield drinking water sources and groundwater recharge areas from contamination. 2. Encourage the use of riparian-area livestock fencing to reduce or prevent water-borne pathogens. 3. Control sediment from dirt roads, fires/burned areas and agricultural operations. 4. Encourage community composting; make available to increase carbon sequestration in soil. 5. Reduce invasive species. 6. Resource Conservation Districts provide technical support for agricultural practices and crop systems that result in lower greenhouse gas (GHG) emissions. 7. Address improperly destroyed, sealed, and abandoned wells that can serve as potential pathways for groundwater contamination. 8. Manage/monitor and control Clean Water Act Section 303(d) listing constituents (sediment, temperature, DO, pH, nutrients) through: <ol style="list-style-type: none"> a. Improve systems for irrigation return water b. Irrigated Lands Regulatory Program (ILRP) implementation of cattle exclusion c. Point source exclusions d. Best management practices for timber harvest and catastrophic wildland fire rehabilitation e. Restore wet meadows f. Roads decommissioning and restoration g. Reduce sedimentation into watersheds h. Control pesticide and herbicide contamination
		Floodplains, Meadows, Waterbodies	<ol style="list-style-type: none"> 1. Develop proper land management practices that prevent sediment and pollutants from entering source waters and waterbodies. 2. Restore degraded riparian habitats where elevated sediment or turbidity cause nuisance or adversely affect beneficial uses per the Basin Plan.

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			<ul style="list-style-type: none"> 3. Assess the costs and impacts of current water quality management activities, and use this assessment to guide future implementation programs. 4. Identify abandoned mines throughout the region and assess the level to which these sites contaminate regional waters. 5. Construct and maintain livestock exclusions around sensitive meadow and riparian habitats, particularly in areas that are important for groundwater recharge or source water protection. 6. Assess and Identify source(s) of pollutants to waterbodies. 7. Establish monitoring protocol for marinas and recreational boating facilities. 8. Establish criteria for preventing/monitoring invasive aquatic species introduction to waterbodies 9. Identify where recreational development has harmed water quality in the region and take action to remediate it
18	Salt & Salinity Management	Municipal Services	<ul style="list-style-type: none"> 1. Utilize treatment options such as membrane or distillation technologies 2. Real-time salinity management that improves the coordination of salt loading from upstream point and nonpoint sources to manage a maximum load of salts that does not exceed water quality objectives
19	Urban Stormwater Runoff Management	Municipal Services	<ul style="list-style-type: none"> 1. Coordinate efforts with agencies, stakeholders, and the public to decide how urban runoff management should be integrated into work plans. 2. Work with community to identify opportunities to address urban runoff management. 3. Provide incentives for the installation of low impact development features on new and existing developments. 4. Emphasize source control measures and strong public education/outreach efforts as being the most effective way to manage urban runoff in this highly arid region. 5. Increase community education efforts in coordination with organizations currently doing this work to include "drains to river" notification on storm drains and awareness programs for proper chemical disposal.
Objective: Practice Resource Stewardship			
20	Agricultural Land Stewardship	Agricultural Land Stewardship	<ul style="list-style-type: none"> 1. Cultivate state payments for ecosystem services programs that compensate landowners for their stewardship while reducing the cost of regulatory compliance and delivering measurable conservation benefits. 2. Maintain working lands employing conservation easement programs for wildlife, agricultural land, grasslands, forestlands, floodplains, and scenic and recreational open space, with preference for those that protect the highest priority resource lands and that protect lands conserving multiple values simultaneously.

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			<ul style="list-style-type: none"> a. Educate landowners about the tax relief, estate planning, and other benefits of agricultural conservation easements. 3. Develop on-farm irrigation ponds and practices that provide off-stream capture of winter stormwater for summer use. Evaluate benefits for economic viability, local water supply, watershed management, flood control, groundwater recharge, mitigation of climate change, wildlife habitat, etc. 4. Implement promising agricultural practices and strategies that reduce net GHG emissions and increase carbon sequestration. 5. Create an inventory of soil organic carbon content. 6. Explore opportunities for farmer-to-farmer education, demonstration, and outreach on successful conservation programs. 7. For grant-funded projects, document project success and share lessons learned and successes with other growers. 8. Protect wildlife habitat on working lands to benefit pollinators and migration routes. 9. Stabilize stream banks and improve riparian forestation to slow bank erosion and filter drainage water from the fields. 10. Utilize proven or promising grazing, forest and brush management practices to reduce catastrophic wildfire risk, where appropriate. 11. Employ recreational opportunities that benefit preservation and sustainability of working/agriculture lands. 12. RCDs, Natural Resources Conservation Service (NRCS), Sierra Nevada Conservancy, Upper Feather River Watershed Group, UC Cooperative Extension and other public and private agencies should educate and support agricultural producers around grants and other incentives available to support agricultural strategies outlined in this plan. 13. Support development or continuance of agriculture-supportive and preservation language in county general plans, such as: <ul style="list-style-type: none"> a. Preservation of agriculture lands b. Encouraging new producers c. Right-to-farm ordinances d. Healthy locally produced food supply e. Support for farmers markets f. Public awareness of the value of agriculture, including educational curriculum g. Efficient agricultural permit procedures

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			<ul style="list-style-type: none"> h. Supports for economic viability of agricultural producers i. Market supports for local agriculture products <p>14. Leverage local, state and federal agricultural conservation entity support for agricultural infrastructure investments, marketing assistance and land stewardship practices and strategies.</p> <ul style="list-style-type: none"> ● 15. Develop alternative and/or flexible cropping systems/patterns for repeat dry-year scenarios and predicted decrease in overall snowpack and changes in precipitation patterns. ● 16. Develop channels for gathering and sharing ag-related climate change mitigation practices. ● 17. Manage working agricultural land to build or maintain carbon sequestration capacity, while maintaining productivity for food/fiber production.
21	Ecosystem Restoration	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> 1. Create programs that support and fund the identification of stream flow needs. ● 2. Establish biological reserve areas that connect or reconnect habitat patches. ● 3. Expand riparian habitat. ● 4. Devise climate change adaptation plans that benefit ecosystems, water, and flood management. ● 5. Reproduce natural flows in streams and rivers. ● 6. Control non-native invasive plant and animal species. ● 7. Filtering of pollutants and recharging aquifers. 8. The protection and preservation of springs as water supply sources as well as valuable ecological and spiritual resources in the region. ● 9. Encourage a natural sediment transport regime through minimizing areas of excessive erosion and sedimentation and encouraging the transport of substrate through habitat restoration and changes in reservoir and hydrologic system management. 10. Remove barriers to fish migration in rivers and streams; assess culverts for adequate passage of aquatic organisms as appropriate.
		Uplands and Forest	<p>Support work programs that:</p> <ul style="list-style-type: none"> ● 1. Maintain and restore a diversity of historic habitats. ● 2. Connect and expand important habitat areas. ● 3. Protect habitats and habitat connectivity from catastrophic wildfire. ● 4. Protect riparian habitats and habitat connectivity from catastrophic wildfire. ● 5. Protect habitats and habitat connectivity from catastrophic wildfire to maintain natural filtering of pollutants and for the recharging of aquifers. ● 6. Implement climate resiliency plans. ● 7. Benefit ecosystems, water, and flood management by protecting habitats and habitat connectivity from

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			<p>catastrophic wildfire.</p> <ul style="list-style-type: none"> ● 8. Reintroduce managed fire where and when appropriate. ● 9. Restore the forest hydrograph. This can be accomplished by reducing unnatural, fire suppression-caused conifer densification and species imbalance, and thereby restoring natural base flows and pulse flows in streams and rivers. ● 10. Control non-native invasive plant and animal species. ● 11. Conserve springs as water supply sources. Springs are valuable ecological and spiritual resources in the region. Protect spring and wetland habitats from catastrophic wildfire. ● 12. Minimize areas of excessive erosion and sedimentation through implementation of Best Management Practices, watershed management, and through reduction of catastrophic wildfire. ● 13. Reduce road culvert barriers to fish and amphibian migration in rivers and streams by assessing culverts for adequate passage of aquatic organisms. Prioritize passage improvement work as appropriate.
22	Forest Management	Uplands and Forest	<ol style="list-style-type: none"> 1. Support work programs that foster connections between forest management and restoring the surface and groundwater hydrograph in forested landscapes. Include integrated research and implementation projects for assessing: <ol style="list-style-type: none"> a. The effects of landscape-scale fuels reduction for enhancing beneficial uses of water b. The effects of vegetation and fuels management on soil moisture, groundwater recharge, and streamflows c. The quantification of both the short and long-term effects of prescribed fire water cycling and the cycling of soil nutrients d. The determination of the impacts of burn frequency and intensity on infiltration, percolation, surface runoff, and groundwater discharge ● e. The effects of different severity wildfires on water quantity, water quality, and aquatic organisms f. The role and magnitude of groundwater storage in mountain meadows and surrounding forests including effects on streamflows and flood flows ● g. The quantification of sediment sources and erosion processes in unmanaged, managed, and high-severity burned forests h. The effects of riparian forests in maintaining stream and groundwater hydrology, water quality and nutrient cycling. i. The habitat effects of different forest and meadow conservation strategies j. The effects of urban trees in reducing nonpoint source pollution ● k. The effects of managed forestland fuels in reducing GHG emissions from catastrophic wildfire

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			<ul style="list-style-type: none"> ● l. The effects of high severity fire conversion of mature forests to brushfields, and the resulting effects on carbon sequestration, groundwater storage, and the volume and timing of streamflows ● m. The effects of brushfield reburn cycles on carbon sequestration, groundwater storage, and the volume and timing of streamflows <ul style="list-style-type: none"> n. The regionally specific and pre-fire suppression extent of brushfields and mature forest habitats for specific forest species o. The effects of increasing conifer densities on the surface and groundwater forest hydrograph ● p. The short- and long-term effects of timely post-fire rehabilitation and restoration strategies. Evaluate effects on forest health, GHG emissions, water quality, and public safety ● 2. Support a program of work that includes monitoring and research on watershed trends. 3. Support the long-term monitoring needed to understand hydrologic changes resulting from climate change and management actions. Support more data collection stations in order to accurately determine how changes in hydrology and water quality are related to climate change and forest management activities: <ul style="list-style-type: none"> a. Additional stream gauges are needed throughout the forested regions of California to adequately represent the existing range of hydroclimatic and geologic conditions. In particular, gauges would be helpful in both managed and “pristine” watersheds b. Additional precipitation stations and snow courses are needed to increase the accuracy of determinations of climatic trends and evaluations of effects of management activities c. Additional water quality and sediment monitoring stations are needed to quantify the effects of climate change and forest management activities on surface water quality d. Additional long-term monitoring wells and aquifer infiltration, isotope, and recharge studies would be useful for understanding groundwater resources in forested watersheds e. Additional projects and studies to characterize regional surface water, groundwater and aquifer interactions on public, private, and tribal lands
		Tribal Advisory Committee	<ul style="list-style-type: none"> ● 1. Increase landscape productivity by increasing ecosystem diversity and resilience through low and moderate intensity fire. ● 2. Increase landscape and climate change resilience through low and moderate intensity fire to increase fire succession mosaics. 3. Collaboratively develop projects and studies utilizing TEK as a monitoring tool of water quantity and quality over time. 4. Assess effects of fire succession in reducing invasive species and re-establishing fire adapted native

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			species through collaborative projects and studies using TEK.
23	Land Use Planning and Management	Agricultural Land Stewardship	<ul style="list-style-type: none"> ● 1. Develop or continue agriculture-supportive and preservation goals and strategies in county general plans, such as: <ul style="list-style-type: none"> a. Preservation of agricultural lands b. Encouraging new producers c. Right-to-farm ordinances d. Healthy locally produced food supply e. Support for farmers' markets f. Public awareness of the value of agriculture, including educational curriculum g. Efficient agricultural permit procedures h. Supports for economic viability of agricultural producers i. Market supports for local agriculture products ● 2. When conducting general plan updates, address relevant water management issues including water supply, water quality, water affordability, flood risk reduction, sedimentation and adequacy of services for residents. ● 3. Identify and assess groundwater recharge areas for groundwater supplies and limit development in those locations. ● 4. Plan for urban green zones, community gardens, school gardens, rainwater catchment, graywater and similar water conservation and management strategies. ● 5. Encourage compact and sustainable development patterns; discourage urban sprawl. ● 6. Collaborate with agencies and local governments to identify opportunities to maximize water conservation, groundwater recharge, storm water capture, and other water management strategies that rely on local land use planning for effective implementation. ● 7. Coordinate plan development among water management districts, flood control districts, RCDs, county and city governmental bodies, regional water masters, watershed managers, and others around water and related resource management strategies.

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			<ul style="list-style-type: none"> ● 8. Continue use of the CEQA process to mitigate the significant impacts of new development on resources including agricultural land, wildlife habitat, open space, floodplains, recharge areas, wetlands, and water supply, among others.
		Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> ● 1. Increase communication between land use planners and water managers. ● 2. Plan for growth in a way that considers water resource features such as streams, wetlands, and groundwater recharge areas, water quality, and flooding. ● 3. Direct development away from undeveloped mountain meadows.
		Municipal Services	<ul style="list-style-type: none"> ● 1. Plan for more compact and sustainable communities that will assist in reducing reliance on the state's water supply. ● 2. Plan for growth in a way that considers the availability of water supplies, water resource features, wetlands, groundwater recharge areas, and policies and regulations about water quality, drainage, and flooding. ● 3. Increase and enhance communication between land use planners and water managers.
		Uplands and Forest	<ul style="list-style-type: none"> ● 1. Increase communication between land use planners and water managers. ● 2. Plan for growth in a way that conserves water resources such as streams, wetlands, springs, groundwater recharge areas, natural floodways, and water quality. ● 3. Direct development away from undeveloped mountain meadows, floodplains, and alluvial fans ● 4. Develop watershed information and strategies to update local land use decision makers on opportunities for maintaining and improving watershed functions
24	Recharge Area Protection	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> ● 1. Restore and, where possible, protect meadows as recharge areas. ● 2. Encourage the preparation of and implement groundwater basin management objective plans to monitor and/or minimize water transfers to protect groundwater supplies and recharge zones. ● 3. Encourage science-based ecological restoration on public and private lands to maximize watershed function and recharge. ● 4. Identify and inventory actual and potential recharge areas throughout UFR Region.

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25	Sediment Management	Agricultural Land Stewardship	<ul style="list-style-type: none"> 1. Foster outreach and education on erosion and sediment management, new state requirements for irrigated land sediment management, and promising practices. 2. Evaluate strategies that manage fine solid fragmented material such as silt, sand, and clay, which is suspended in or settled on the bottom of waterbodies, for use in agricultural applications, wetland establishment and other beneficial re-uses. 3. Evaluate and coordinate management of agricultural water delivery systems for sediment build-up and mitigation needs. 4. Evaluate and manage areas such as dirt roads, burned areas, insufficient-capacity culverts and bare channels in the UFR that are susceptible to creating excessive sedimentation. 5. Remediate sedimentation of the Feather River and other Upper Feather River drainage dams. 6. Evaluate and plan for potential remediation of contaminated sediments.
		Uplands and Forest	<ul style="list-style-type: none"> 1. The Natural Resources Agency and California Environmental Protection Agency should support an integrated approach to achieve the maintenance of stable watersheds where sediment yield mimics the natural sediment production that would occur in the absence of anthropogenic conditions. 2. Federal and state governments should support development of guidelines to identify when geomorphic assessments of streams for watershed stability are appropriate, to prevent undue delays in processing permits and ensure that studies are scaled to project size. 3. Where required, responsible agencies should utilize a common GIS mapping framework, and support sediment and flow monitoring programs. They should determine the sediment yields from a watershed and sediment budgets for downstream areas that include consistent monitoring protocols for scientifically defensible data of comparable quality throughout the state. 4. Post burn assessments and actions should include sediment and erosion remediation.
26	Watershed Management	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> 1. Create a scientifically valid tracking and reporting method to document changes in the watershed. 2. Establish a scientifically valid means of tracking and reporting changes in the UFR Region's major sub-watersheds that provide reliable, current information to local communities, state and federal agencies, and others, regarding the net effects of management against the background of external change. 3. Restore and preserve stream channel morphology to provide floodwaters access to the floodplain and to encourage stable banks and channel form. 4. Assess the performance of projects and programs. 5. Provide watershed information to better inform local land use decision makers on how to maintain and improve watershed functions. 6. Use watershed approaches in which all RMS strategies are coordinated.

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			<ul style="list-style-type: none"> ● 7. Preserve habitats and ecosystems that provide functions essential to water management, including: <ul style="list-style-type: none"> a. Erosion prevention, healthy sedimentation levels, water temperature preservation, and the provision of a cold-water pool in the summertime b. Promote conservation of terrestrial and aquatic habitat connectivity c. Protect, preserve, and restore, where appropriate, the riparian zone ● 8. Identify where noxious weeds may become a serious problem for recreational use, water quality, ecosystem integrity, or other reasons, and manage those infestations accordingly. 9. Improve data collection and sharing among/between watershed stakeholders and outside entities. ● 10. Increase levels of community knowledge regarding their watershed and encourage responsible stewardship and protection. 11. Coordinate with and between stakeholders where appropriate. 12. Build regional capacity through stakeholder partnerships and collaboration. ● 13. Assess the connection between groundwater and spring and surface water sources to better understand their interactions. ● 14. Proactively address the recovery of special-status species, at both watershed and population scales, and incorporate measures to avoid future listing of other at-risk species. ● 15. Protect soil resources; restore the functions of drastically disturbed soils, to slow runoff and increase rainfall infiltration. ● 16. Retain intact floodplain and other wetlands, to the extent possible, to maintain or increase residence time of water in the watershed.
		Uplands and Forest	<ul style="list-style-type: none"> ● 1. Support a work program for implementing projects that: <ul style="list-style-type: none"> a. Develop TEK tracking and reporting methods b. Create and maintain scientifically valid tracking and reporting methods to document hydrograph and precipitation changes in the watershed c. Establish scientifically valid means of tracking and reporting baselines and trends in watershed condition. Employ LIDAR and archival photo records to display and differentiate the net effects of management against the background of a more variable precipitation regime d. Restore and preserve stream channel morphology to provide access by floods to the historic floodplains e. Restore and preserve stream channel morphology to encourage stable banks and channel form for the regeneration of riparian vegetation f. Assess the performance of watershed projects and programs by integrating TEK and tribal

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			<ul style="list-style-type: none"> restoration approaches with other metrics g. Develop landscape scale projects that coordinate multiple RMS strategies h. Maintain and enhance ecosystem functions in a changing precipitation regime i. Integrate peak flood attenuation with protecting habitats and migration corridors from catastrophic wildfire j. Advance the use of managed fire to enhance watershed function and resilience k. Assist property owners in implementing watershed management activities <ol style="list-style-type: none"> 2. Involve forest managers in integrated water and land management. 3. Develop science for informing the determination of objectives and strategies for forested meadows. 4. Use expanded interagency agreements to allow federal, state, tribal, and non-governmental agencies and entities to share expertise, staff time, and funding across jurisdictional boundaries for the purposes of landscape-scale watershed and water quality protection and improvement. 5. Use expanded interagency agreements where federal, state, and non-governmental agencies and entities share expertise, staff time, and funding across jurisdictional boundaries at landscape scales for the reintroduction of controlled fire and for the incorporation of tribal TEK. 6. Develop a science-based public education campaign directed at water users and communities in the Central Valley, Bay Area, and Southern California to increase support for forest management. 7. Develop integrated state and federal watershed resource enhancement and conservation climate adaptation plans for the forested headwaters areas and for urban forestry. 8. Involve federal agencies as partners with tribal, state, and local entities for grant programs, and allow federal funds and in-kind services to be used as grant matches. 9. Streamline vegetation and fuels management projects that reduce the risks of catastrophic wildfires with net beneficial effects on groundwater storage, surface water flows, and on water quality. 10. Work to reduce liabilities and other barriers to managed burning.
Objective: People and Water			
27	Economic Incentives	Municipal Services	<ul style="list-style-type: none"> 1. Encourage regular examination and adjustment, where necessary, of water rates. 2. Encourage use of tiered rate structures. 3. Adopt policies that promote long-term water use efficiency.
		Uplands and Forest	<ul style="list-style-type: none"> 1. Develop programs for supporting biomass utilization, enhancing groundwater recharge, reducing catastrophic fire, and reducing GHG emissions as integrated as essential elements of restoring forest ecosystem health across California's forestlands. 2. Develop TEK and other scientific evaluations for implementing such programs at the landscape scale in

#	RMS	Workgroup of Origin	Workgroup Strategy Recommendations
			<p>key watersheds of statewide importance.</p> <ol style="list-style-type: none"> 3. Assist with developing the capacity of landowners and local organizations and programs to carry out RMS implementation. 4. Work with federal, state, and local legislators, agencies and entities, to reduce liabilities and other barriers to managed burning.
28	Outreach and Engagement	Agricultural Land Stewardship	<ol style="list-style-type: none"> 1. Utilize both electronic and conventional media for outreach and engagement. 2. Engage public in creation of water and resource management plans. 3. Conduct outreach and education around available water management data sources; local agencies, their functions and contact information; and priorities from the UFR IRWMP. 4. Explore and coordinate common project goals and areas of need across organizations and agencies for more robust and integrated funding proposals. 5. Conduct outreach and engagement with stakeholders to advocate for policy change supportive of UFR IRWMP. 6. Conduct field trips, tours, and education projects and promising management practices for youth and adults. 7. Encourage use of the Ranch Water Quality Planning Short Course, which promotes the California Rangeland Water Quality Management Plan, to generate common understanding, discourse and action. 8. Develop opportunities for board leadership and management training for agencies and organizations in the UFR.
		Uplands and Forest	<ol style="list-style-type: none"> 1. Support projects that incorporate outreach and education into project implementation. 2. Support and expand existing educational programs such as: tribal education programs; the Forest Institute Training for teachers "FIT" program; the "Learning Landscapes" program; the Butte County Fire Safe Council's 6th grade "fire aware" Charter School field training program; the Feather River Watercourse, "Plumas to the Pacific;" exemplary outdoor education programs offered to students (pre-school through junior college); and other entities in the UFR Region. 3. Support work with adjacent and downstream landowners to improve understanding of benefits that result from large scale and coordinated watershed projects.
29	Water and Culture	Tribal Advisory Committee	<ol style="list-style-type: none"> 1. General Beneficial Use Goal: Beneficial uses of water include those that support fish consumption, aquatic and wildlife habitat for plant and animal species, recreation, and water quality and quantity to support such systems and activities. This includes those uses that support the cultural, spiritual and traditional lifeways of California Indian Tribes, Tribal communities and families. 2. TEK Goal: Integrate and apply Traditional Ecological Knowledge in collaboration with Tribes, Tribal

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			organizations, and cultural traditional ecological practitioners. The UFR RWMG recognizes the ethical responsibility of project proponents to collaborate for the inclusiveness of the whole community and therefore to reach the Maidu family(s) with traditional responsibility to the project location.
30	Water-Dependent Recreation	Floodplains, Meadows, Waterbodies	<ul style="list-style-type: none"> 1. Develop invasive species prevention measures. 2. Enhance the educational qualities of recreational activities throughout the region. 3. Work with a variety of stakeholders (USFS, power providers, educational institutions, non-profits) to identify recreational and educational opportunities. 4. Ensure that current and future recreational developments do not endanger water quality and/or environmental characteristics. 5. Develop a plan to resolve legacy pollution impacts on recreational waters. 6. Develop BMP guidance to reduce recreation-based water quality impacts, including impacts from recreational vehicles such as reduced pollution of marine engines and parking lot runoff. 7. Test surface water quality more often and make real-time water quality information for surface waters more accessible online and at recreation sites. 8. Educate residents and businesses in the watershed about their role in protecting water quality and recreational opportunities. Explain water quality issues to the public in more understandable and compelling ways. 9. Restore sustainable populations of native and/or game fish. 10. Maintain and restore vegetation along rivers and streams that support and enhance outdoor recreation. 11. Participate in the National Water Trails System.
31	Other Strategies	Agricultural Land Stewardship	<ul style="list-style-type: none"> 1. Promote snow fences and/or windbreaks along roadways. 2. Reestablish historic wetlands where appropriate. 3. Explore rain-fed agricultural opportunities for UFR Region.

#	RMS	Workgroup of Origin	Workgroup Strategy Recommendations
		Uplands and Forest	<ul style="list-style-type: none"> 1. Manage fire and fuels and strategically locate fire breaks for ridgeline lightning, roadway, and railroad ignitions. 2. Manage fire and fuels for the protection of critical habitats. 3. Manage snow zone fuels and fire. 4. Reduce wildfire liability. 5. Manage Wildland-Urban Interface (WUI). 6. Use Traditional Ecological Knowledge to reintroduce historic fire regimes. 7. Community recharge area management to protect domestic and agricultural wells from catastrophic wildfire and from reduced groundwater infiltration or excessive siltation. 8. All-scale biomass utilization, including community and tribal biomass projects. 9. Manage landscape-scale forest and fuels that include multiple fire and fuels management strategies.
	Wastewater/ NPDES	Municipal Services	<ul style="list-style-type: none"> 1. Water/wastewater treatment: This resource management strategy potentially includes integration of agricultural and domestic wastewater into the water supply equation. Water/wastewater treatment has been a significant issue for the region's special district for several decades. <ul style="list-style-type: none"> a. Consider regional facilities b. Consider water/wastewater treatment as a supply option, through groundwater recharge and/or other means 2. Aging wastewater infrastructure and the need for upgrades to meet new and revised state standards. This strategy will also be important when considering water-recycling opportunities. Actions might include: <ul style="list-style-type: none"> a. Facility upgrades b. Assessment of private sewage treatment for safety next to wells in areas of semi-dense development (one-acre plots) c. Development of strategies for wastewater treatment to ensure the maintenance of receiving water quality 3. Infrastructure reliability: This strategy recognizes the importance of maintaining and upgrading infrastructure for water supply, treatment, and distribution; wastewater collection, treatment, and disposal; and recycled water treatment and distribution. Infrastructure improvements are continually needed as facilities age, demands on their use increase (due to population growth, degraded water quality, or increased water quality standards), and new technologies are introduced. 4. Provide regional operator training to enhance knowledge of wastewater collection, treatment, and disposal that will increase the certified operational pool in the area (succession planning). 5. Increase public outreach activities to promote the water and wastewater fields as career paths.

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