MATILIJA DAM REMOVAL, SEDIMENT TRANSPORT, AND ROBLES DIVERSION MITIGATION PROJECT

DRAFT WATER SUPPLY MITIGATION CONCEPTS EVALUATION REPORT

AUGUST 13, 2015

Prepared for:
Ventura County Watershed Protection District

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Table of Contents

1.0 Introduction

1.1 Purpose and Background

Since its construction in 1947, the 168-foot-high, arched concrete Matilija Dam in Ventura County, California had blocked the transport of nearly 8,000,000 cubic yards (cy) of fine and coarse sediment from naturally moving downstream to the ocean. This has resulted in loss of the reservoir's original function of water storage, loss of downstream sand- and gravel- sized materials necessary for promoting habitat for a variety of wildlife species, loss of sediment needed to maintain beaches at Surfer's Point, and increased erosion of the Ventura River streambed. The dam, with its non-functioning fish ladder, also prevents Southern California Steelhead from reaching upper Matilija Creek.

Ventura County Watershed Protection District (VCWPD) has contracted AECOM (formerly URS) and Stillwater Sciences (the Consultant Team) to evaluate a range of concepts for dam removal. Each alternative concept involves the flushing of some amount of sediment, which may impact downstream water supply within the Ventura River watershed (Figure 1-1), with potential impacts to surface and groundwater supply. There are a variety of water providers within the watershed. This memorandum considers potential impacts to each of the major providers, along with potential mitigation options.

The purpose of this memo is to present and evaluate options to mitigate water supply impacts associated with current concepts being considered for the removal of Matilija Dam.

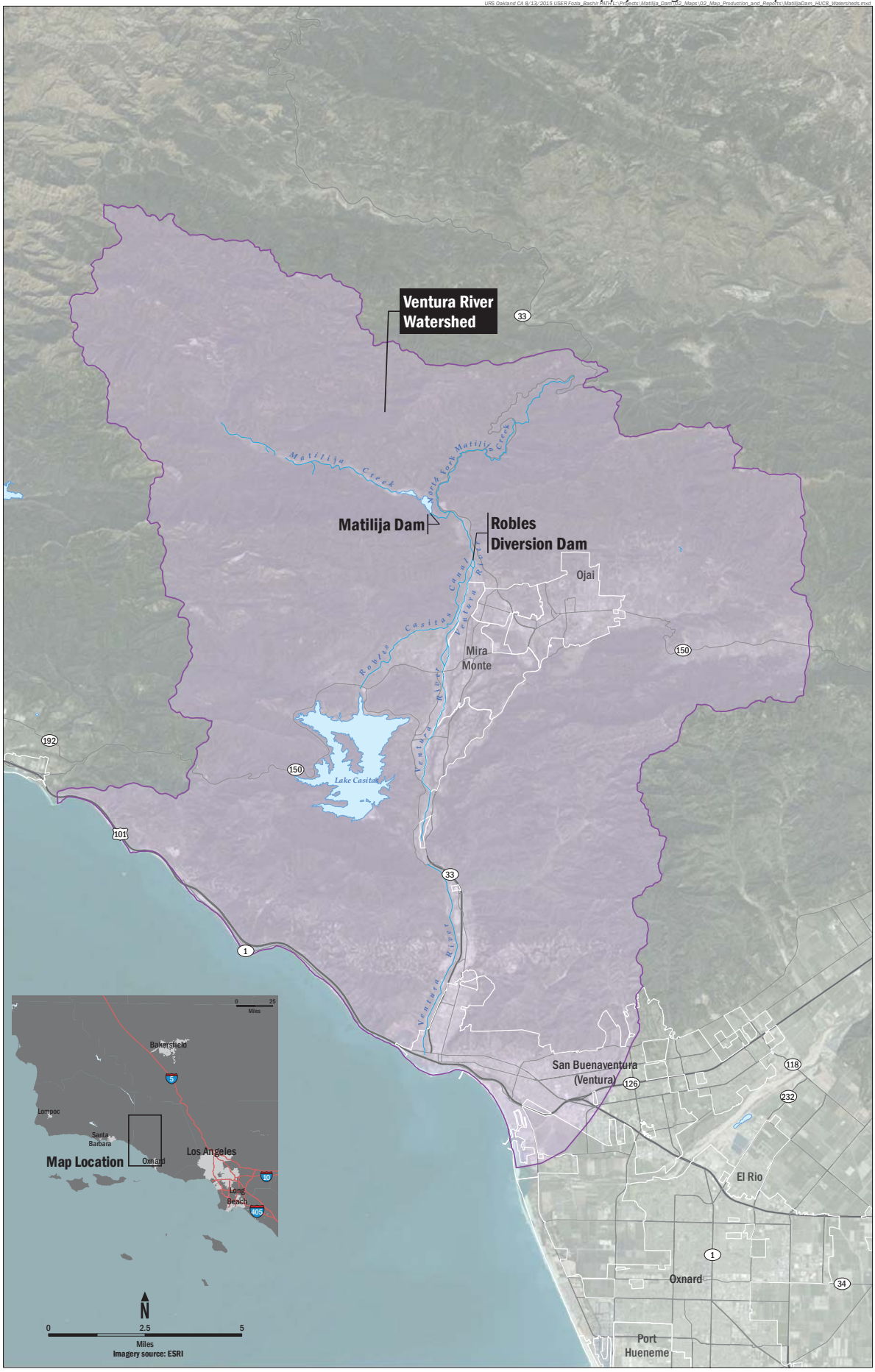

Figure 1-1:Location and map of Ventura River Watershed

1.2 Organization of this Report

This concept evaluation report is organized as follows:

- **Section 1.0 Introduction:** summarizes the report purpose, project background and report organization.
- **Section 2.0 Other Studies:** summarizes previous and ongoing work related to this report.
- **Section 3.0 Water Providers:** provides a detailed description of surface and groundwater providers within the watershed, in addition to a summary of mechanisms that could potentially impact water supply.
- **Section 4.0 Mitigation Options:** describes a variety of water supply mitigation options that have been investigated to potentially offset impacts to water providers related to removal of Matilija Dam.
- **Section 5.0 Recommendations:** summarizes the analyses and options from Section 4.0, and provides recommendations.
- **Section 6.0 Limitations:** describes the limitations and the assessments and evaluation provided in the report.
- **Section 7.0 References**: provides a reference list for the sources cited through this report.

2.0 Other Studies

2.1 Summary of Dam Removal Alternatives

Under Task 1.3, the Consultant Team has evaluated a range of potential dam removal concepts, which are briefly described below. Full descriptions and a multi-criteria evaluation are detailed in the *Draft Dam Removal Concepts Evaluation Report* produced by the Consultant Team (AECOM and Stillwater Sciences, 2015). The three dam removal concepts (DRCs) under consideration and their anticipated sediment release characteristics are as follows:

- DRC-1 Containment Berm with High Flow Bypass
  - Description: This concept would involve removing the dam and building a temporary containment berm to hold the reservoir sediment in place, and bypass tunnel to divert creek flow to North Fork Matilija Creek, until a high flow event occurs. During the high flow event, the flow would be allowed to return to Matilija Creek to erode a large portion of reservoir fine sediments.
  - Sediment Release: With this concept, sediment is released in high concentrations during one high flow events as a channel is downcut through the fine sediment behind the reservoir (Phase I), with subsequent events removing additional fine sediments at a declining rate through local mass failures on the bank (Phase II).
- DRC-2 Uncontrolled Orifices with Optional Gates
  - Description: This concept would involve boring tunnels at the base of the dam and then blasting open the tunnels when a high flow event occurs to erode a large portion of reservoir fine sediments. This concept would include the option of installing gates on the upstream end of the tunnel orifices if it was found the large storm did not remove an adequate amount of the accumulated fine sediment from the reservoir. The gates would be closed to allow the reservoir to refill to minimize additional water quality impacts until the next high flow event occurs. The dam would be removed when a sufficient amount of the accumulated fine sediment has been eroded from the reservoir.
  - Sediment Release: Similar to DRC-1, sediment is released in high concentrations in one high flow events where a channel is cut through the fine sediments (Phase I) and at a declining rate thereafter (Phase II), as bank failures continue to stabilize the channel.
- DRC-3 Temporary Upstream Storage of Fine Sediment
  - Description: This option would involve mechanical removal of sediment behind the reservoir and temporary upstream storage of both fine and coarse sediment to create a channel through the lower third of the reservoir approximately along the pre-dam creek alignment at the pre-dam creek elevations. The dam would be removed when earthwork is complete.
  - Sediment Release: DRC-3 would result in significantly reduced peak sediment loading during the first post-removal high flow events, due to the prior mechanical removal of much of the fine reservoir sediment.

2.2 Summary of Hydrologic Evaluation

A preliminary evaluation of watershed hydrology was completed by the Consultant Team under Task 3.2 entitled *Hydrologic Assessment for Water Supply* (URS and Stillwater Sciences 2014). This memorandum focused on developing an understanding of surface water supply and demand associated with Casitas Municipal Water District (CMWD), which is one of the largest regional water suppliers. The analyses were based on historical diversion and stream gage data and evaluated supply scenarios in an attempt to clarify the relative significance of Robles Diversion (compared to other sources to Casitas Reservoir). A schematic and summary of the system is presented in Section 3.0 of this memorandum.

The findings of the hydrologic analysis included the following key points:

- During the period of record available for this analysis, Robles diversion provided approximately 31% of the inflow into Casitas Reservoir. This percentage could potentially have been lower if diversions had been managed in some instances to prevent reservoir spilling.
- There is a typical pattern of oscillation between wet and dry periods in the Ventura River watershed that has been on the order of a 10 to 15 year cycle for the past 50 years, with at least one 20 year drought cycle over the past 100 years.
- Implementation of a dam removal alternative that restricts diversions (allows diversion of a portion of storm or allows diversion between storms) or prevents diversions (no diversions throughout the period) during a typical wet cycle period and when the reservoir is full or nearly full, would have little to no effect on water levels in Casitas Reservoir.
- Implementation of a dam removal project during one of the typical dry cycles that suspends Robles diversions would significantly reduce water levels in Casitas Reservoir. However, if the impact could be limited to a few storms, it is probable that loss of storage capacity would be limited to between 4-15% (10,100 to 38,100 acre-feet). The lost volume would persist until the next wet cycle when it would be restored.

2.3 Summary of Sediment Characterization and Transport

In order to characterize and quantify the sediment stored behind the Matilija Dam, existing data and topography from 1947 and 2005 were reviewed and analyzed under Task 2.2 (Stillwater Sciences 2014). Based on these analyses, there were approximately 6.9 million cubic yards (mcy) of sediment stored behind the Matilija Dam as of 2005, comprising approximately 3.0 mcy of silt and clay, 2.2 mcy of sand, and 1.7 mcy of gravel, cobble, and boulders.

AECOM and Stillwater Sciences (2015) found that fine sediment transport immediately after the dam removal for DRCs 1 and 2 would result in initially much higher fine sediment yields than under natural conditions, but that yields would drop immediately and rapidly in the following days. Within two weeks of typical flows following a high-flow storm event, the fine sediment yield would be indistinguishable from that arising from the natural contribution from the watershed as a whole.

AECOM and Stillwater Sciences (2015, Appendix C) also summarized the expected transport of bedload following dam removal. Of note, the study found that significant deposition would be expected in the areas immediately downstream of the current dam and as far as 2 km downstream of Robles diversion

dam, with minor aggradation in localized areas expected up to 7 km downstream of the Coyote Creek confluence.

3.0 Water Providers

There are many interconnected water providers within Ventura County. The principal surface water providers discussed in this conceptual evaluation of mitigation concepts are:

- CMWD, who diverts water from the Ventura River at the Robles Diversion Facility. CMWD's water demand in 2009 was 17,610 AF.
- The City of Ventura, who draws subsurface water from the Ventura River via intakes at Foster Park. The City of Ventura's water demand in 2012 was 18,004 AF for the entire City.

Major urban suppliers of groundwater include:

- Golden State Water of Ojai, who pumps from the Ojai Valley Groundwater Basin and supplement with surface water from CMWD. Golden State Water's water demand in 2009 was 1,778 AF.
- Ventura River Water District, who pumps from the Upper Ventura River Groundwater Basin and supplement with surface water from CMWD. Ventura River Water District's average annual demand is 1,324 AF.
- Meiners Oaks Water District, who pumps from the Upper Ventura River Groundwater Basin and supplement with surface water from CMWD. Meiners Oaks average annual water demand is approximately 1,100 AF.
- CMWD also operates one well in the Mira Monte area in the Upper Ventura River Groundwater Basin.

A map of selected regional groundwater basins is provided in Figure 3-1.

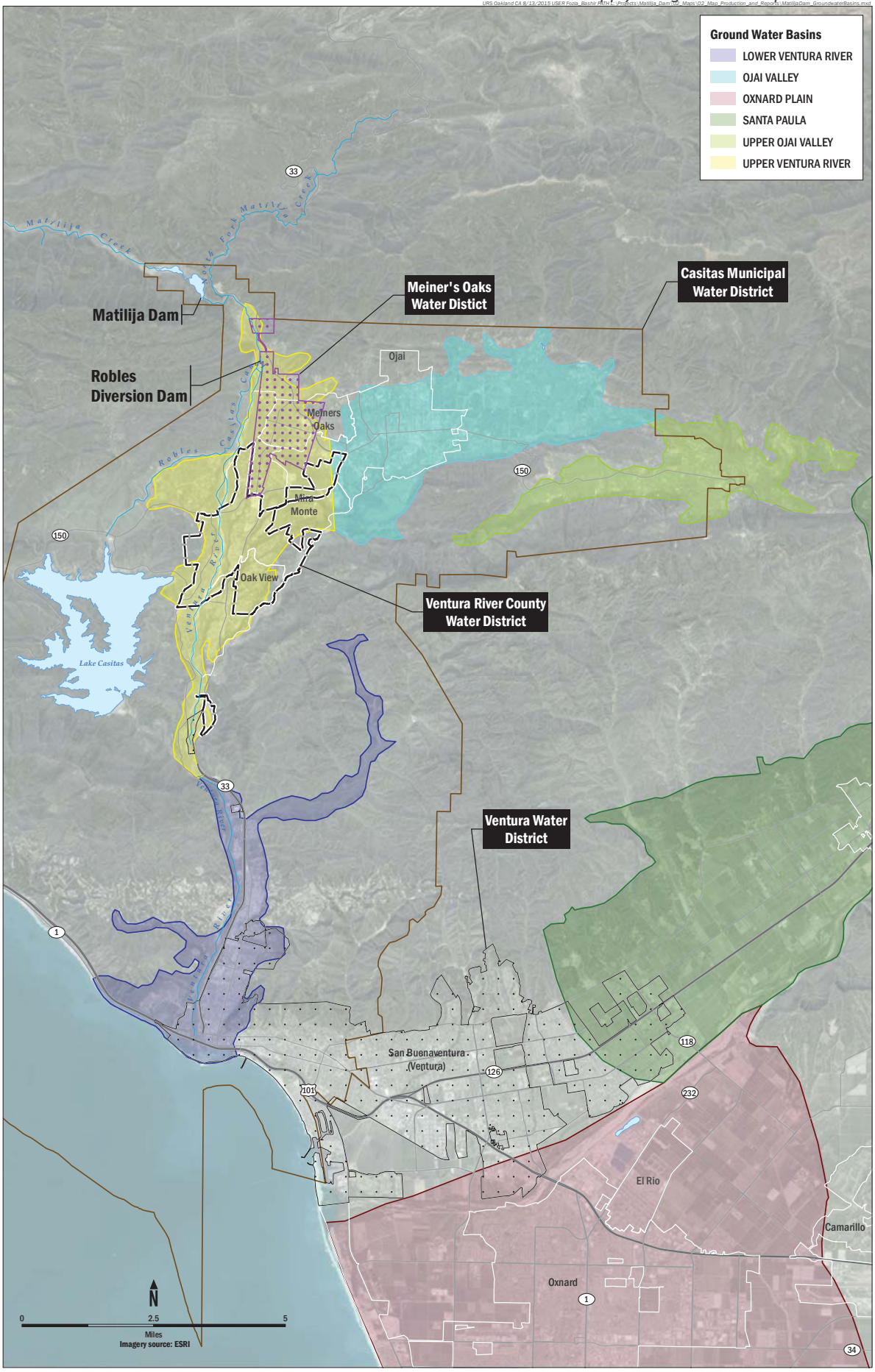

Figure 3-1:Selected Local Ground Water Basins and Water Purveyors in the Vicinity of the Ventura River Watershed

3.1 Surface Water Providers

3.1.1 Casitas Municipal Water District

The CMWD supplies water to approximately 70,000 customers in western Ventura County, including hundreds of agricultural customers and a number of other water utilities. The CMWD boundaries encompass the city of Ojai, Upper Ojai, the Ventura River Valley area, the City of Ventura to Mills Road, and the Rincon and beach area to the ocean and the Santa Barbara County line (the Casitas Service District).

The CMWD was formed in 1952, and Congress authorized the Ventura River project in 1956. The project included the Robles Diversion facility on the Ventura River, the Robles Canal, and Casitas Dam. Construction of Casitas Dam was completed in November 1958, and the reservoir spilled for the first time in 1978. Casitas Reservoir has a capacity of approximately 254,000 acre-feet.

Robles diversion dam is located on the Ventura River near Ojai, California at approximately river mile (RM) 14.16, and supplies water to Casitas Reservoir by canal (Figure 3-2). The normal maximum diversion is approximately 500 cubic feet per second (cfs), however CMWD has not been able to divert the full 500 cfs since the completion of the fish passage project and implementation of the Biological Opinion. The existing diversion dam is a low rock weir with a gated spillway, canal diversion headworks and a fish passage facility located on the right abutment. The diversion weir has a hydraulic height of 13 feet. The fish screen features a chevron-configuration, vertical plate design with traveling brush mechanisms and adjustable velocity distribution baffles.

The canal, including the boxed inverted siphon, is approximately 27,500 feet long with a maximum capacity of 600 cfs. For the majority of its length, an access road parallels the canal and several small bridges provide locations for vehicles to cross over the canal.

Stored water in Casitas Reservoir is piped via the intake structure and tunnel through the dam directly into the water treatment facility located just below Casitas Dam. CMWD supplies all their water to customers from this treatment plant. The outlet works at the end of the tunnel allow for emergency drawdown of the reservoir, with a capacity of 570 cfs (Wickstrum and Merckling, 2011).

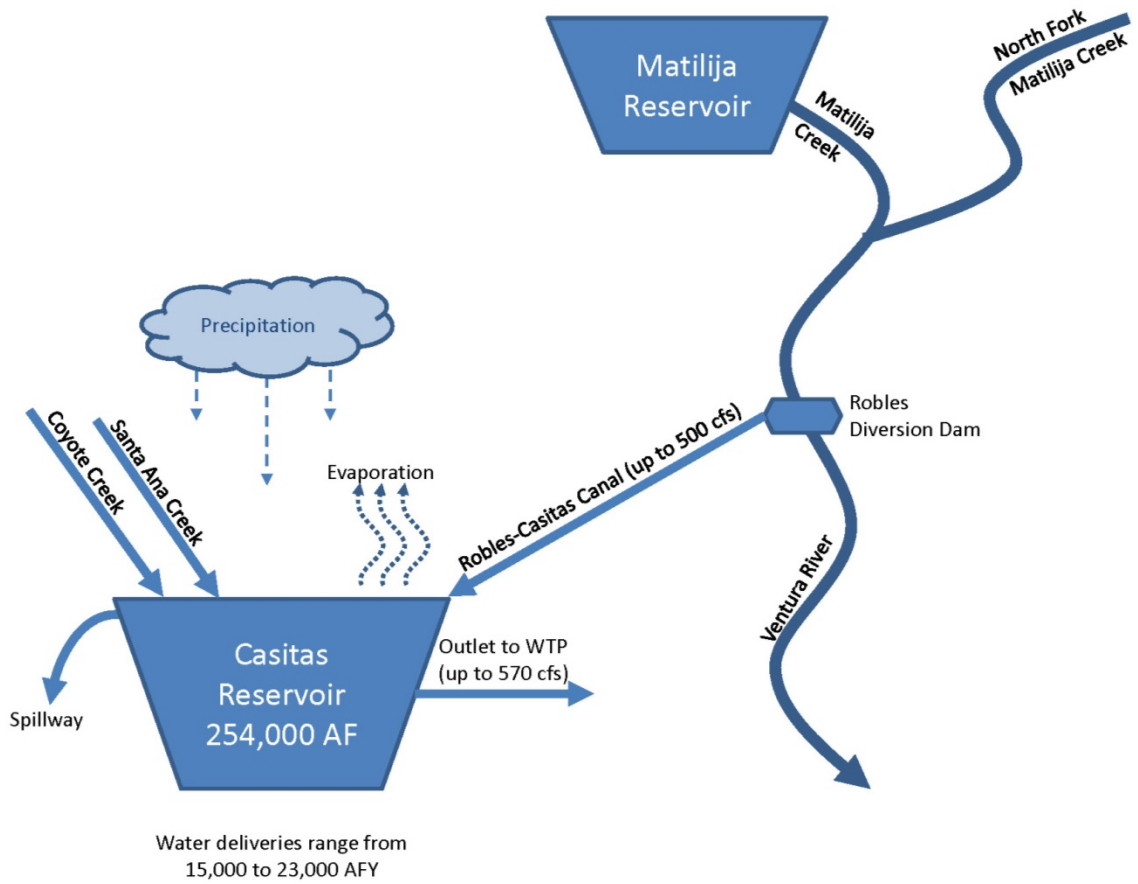

Figure 3-2: Casitas Reservoir and Robles Diversion (Location Map and Schematic)

3.1.2 Ventura Water

The City of Ventura operates Ventura Water. The City's potable water supply is derived from local groundwater basins, CMWD and subsurface intakes on the Ventura River at Foster Park. The City also has a 10,000 acre-foot per year (AFY) allocation from the California State Water Project. To date, the City has not received any of this water because there are no facilities to get the water to the City from its termination at Oxnard Water in east Oxnard. There are presently five local water sources that provide water to the City water system:

- Treated water from the CMWD treatment plant,
- Ventura River Foster Park Area, Wells Mound Groundwater Basin,
- Oxnard Plain Groundwater Basin,
- Santa Paula Groundwater Basin,
- Recycled water from the City's Ventura Water Reclamation Facility (VWRF).

From CMWD, Ventura Water is allowed the maximum amount of its in-district demand, which varies, but is approximately 5,000 AFY on average. This represents a significant proportion of the City's current total in-district and out-of-district water supply, which ranges from 18,000 AFY to 19,600 AFY. Figure 3-3 below presents the City's typical water supply volumes by source.

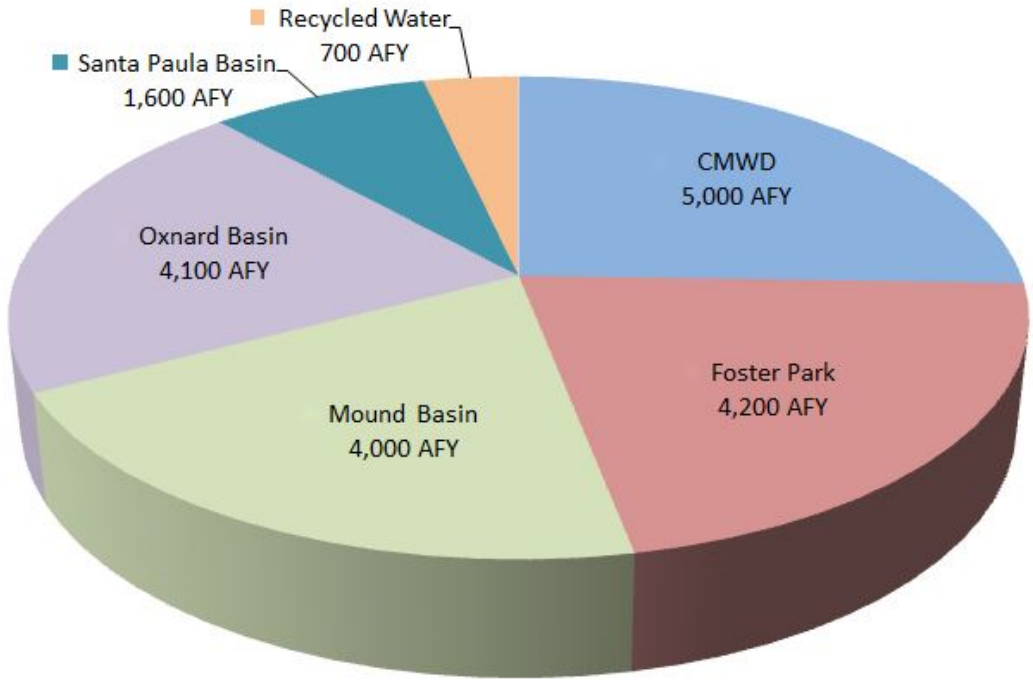

Figure 3-3: Ventura Water Supply by Source [RBF Consulting, 2013]

The Oxnard Plain Groundwater Basin is regulated by the Fox Canyon Groundwater Management Agency. Due to the current drought, the Management Agency issued Emergency Ordinance E in April 2014, reducing the amount of withdrawal from the basin, and eliminating this source of water from the City's supply.

From the Santa Paula Basin, the City is allowed to produce up to a total of 21,000 AF over a 7-year period, with a maximum of 3,000 AFY. The City currently has three wells within this basin, with two currently in operation. The total maximum production from all three wells is 1,600 AFY.

3.2 Groundwater Providers by Basin

There are four groundwater basins in the Ventura River Watershed: Upper Ojai, Ojai Valley, Upper Ventura River and Lower Ventura River. These are tapped by 11 mutual water companies in the watershed, serving from less than 10 to hundreds of customers each. Some providers within the watershed also import water from basins outside the watershed. The Santa Paula and Oxnard Plain basins are also discussed in this section for this reason. The groundwater basins discussed in this conceptual evaluation are shown on Figure 3-1.

3.2.1 Upper Ojai Groundwater Basin

The Upper Ojai Groundwater Basin is the highest basin in the watershed, located above San Antonio Creek, a tributary to the Ventura River. The basin does not supply water to any of the major urban water

suppliers discussed in this memorandum, although it does provide local supply within the watershed and connects to Ojai Valley Basin. The California Department of Water Resources (CDWR) has described the Upper Ojai Basin as follows:

> "The Upper Ojai Valley Groundwater basin is bounded by the Ojai Valley Groundwater Basin on the north, the Topatopa Mountains on the east, Sulfur Mountain on the south, and near impermeable rocks of the Santa Ynez Mountains elsewhere. The valley is drained westward by Lion Canyon into San Antonio Creek and eastward by Sisar Creek to Santa Paula Creek. Average annual precipitation ranges from 24 to 28 inches. Natural recharge into the basin is estimated to be 400 AFY. Recharge into the basin is estimated to be 320 AFY from return irrigation flow and about 600 AFY underflow." (CDWR, 2003)

3.2.2 Ojai Valley Groundwater Basin

The Ojai Valley Groundwater Basin is the source of water for Golden State Water Company and a number of mutual water companies. The CDWR has described the Ojai Valley Groundwater Basin as follows:

> "The Ojai Valley Groundwater Basin is bounded on the west and east by nonwater-bearing Tertiary age rocks, on the south by the Santa Ana fault and the Sulphur Mountain Range, and on the north by Black Mountain and the Topatopa Mountains. The basin is drained by Thacker and San Antonio Creeks to the Ventura River. Average annual precipitation ranges from 20 to 24 inches." (CDWR, 2003)

3.2.3 Upper Ventura River Groundwater Basin

The Upper Ventura River groundwater Basin is an unconfined aquifer and, although it recharges fairly quickly after a series of winter storms, when the Ventura River dries up, basin levels drop significantly after only 2 or 3 years of drought conditions. It is the source of water for CMWD's well near Mira Monte, the City of Ventura's Foster Park Wells, Meiners Oaks Water District's local supply, and numerous mutual water companies. The basin has been described by the CDWR as follows:

> "The Upper Ventura River Subbasin is bounded on the south by the Lower Ventura River Subbasin, on the east by the Ojai Valley Groundwater Basin, and elsewhere by impermeable rocks of the Santa Ynez Mountains….The surface is drained by the Coyote, Matilija, and San Antonio Creeks and the Ventura River. Average annual precipitation ranges from 14 to 24 inches." (CDWR, 2003)

3.2.4 Lower Ventura River Groundwater Basin

The CDWR has described the Lower Ventura River Groundwater Basin as shown below:

> "The Lower Ventura River Subbasin is bounded on the north by the Upper Ventura River Subbasin, on the south by the Pacific Ocean and Mound Subbasin of the Santa Clara River Valley Groundwater Basin, and elsewhere by near impervious rocks of the Santa

> Ynez Mountains. The valley is drained by Canada Larga and the Ventura River. Average annual precipitation ranges from 14 to 16 inches." (CDWR, 2003)

This groundwater basin is directly connected to the Pacific Ocean. The basin is minimally used and most of the wells are agricultural. No public water suppliers use the basin.

3.2.5 Santa Paula Groundwater Basin

The Santa Paula Groundwater Basin is a basin along the Santa Clara River located southeast from the Ventura River Watershed. CDWR describes the basin as:

> "The northern boundary of the Santa Paula Subbasin is the contact between Pleistocene and younger alluvium and impervious rocks of the Topatopa Mountains. The southern boundary is formed by impervious rocks of Oak Ridge and South Mountain, the Oak Ridge fault, and the Saticoy fault... The eastern edge of the subbasin is marked by a bedrock constriction, with the boundary placed at the position of maximum rising water ... The western boundary of the subbasin separates it from the Mound and Oxnard subbasins, with the western boundary placed where there is a distinct change in the slope of the water table... The Santa Clara River and Santa Paula Creek drain the valley westward toward the Pacific Ocean. Average annual precipitation ranges from 14 to 18 inches." (CDWR, 2003)

3.2.6 Oxnard Plain Groundwater Basin

Oxnard Plain Groundwater Basin is regulated by the Fox Canyon Groundwater Management Agency. The basin has had an agreement with the City of Ventura to supply limited amounts of groundwater for municipal distribution. However, due to the current drought, the Management Agency issued Emergency Ordinance E in April 2014, reducing the amount of withdrawal from the basin, and eliminating this source of water from the City's supply. CDWR describes the basin as follows:

> "Oxnard Subbasin is a subbasin of the Santa Clara River Valley Basin, located in southern Ventura County. The northern boundary of the subbasin is the Oak Ridge fault. The southern boundary is formed by contact of permeable alluvium with the semi-permeable rocks of the Santa Monica Mountains…. The eastern edge of the subbasin lies against the Pleasant Valley and Las Posas Valley Basins…. The western edge of the subbasin is the Pacific Ocean…. Calleguas Creek and other tributary creeks drain the surface waters of the area westward into the Pacific Ocean and the Santa Clara River provides recharge along the northern border of the subbasin…. Average precipitation ranges from 14 to 16 inches per year." (CDWR, 2003)

3.2.7 Mound Groundwater Basin

The Mound Groundwater Basin is a basin located along the Santa Clara River. The majority of recharge is from percolation of surface flow from the Santa Clara River and other minor tributaries. CDWR describes the basin as:

"Mound Subbasin underlies the northern part of the Ventura coastal plain in the western part of the Santa Clara River Valley Groundwater Basin. The subbasin is bounded on the north by the Santa Ynez and Topatopa Mountains and on the south by the Oak Ridge and Saticoy faults (CSWRB 1956). The subbasin is bounded on the northeast by the Santa Paula Subbasin (CDPW 1933; CSWRB 1956). The subbasin is bounded on the west by the Pacific Ocean. Ground surface elevations range from sea level in the west to about 400 feet above sea level in the east (CSWRB 1956). The Santa Clara River and tributary creeks drain surface water westward into the Pacific Ocean. Average annual precipitation ranges from 12 to 16 inches." (CDWR, 2003)

4.0 Potential Impacts to Providers

This section describes several types of potential impacts to supply that may be associated with the short-listed dam removal concepts summarized in Section 2. Each type of potential impact could result in a temporary lost opportunity to obtain water from the intended source, or additional treatment costs to ensure water quality standards are met. These potential impacts are not necessarily likely, nor can all potential impacts be foreseen. However, at the conceptual level, they represent the focus of potential mitigation measures discussed in Section 5.0.

4.1 Increased Suspended Sediment

Assessments in AECOM and Stillwater Sciences (2015) indicate that for DRC-1 and 2, elevated (above baseline) concentrations of TSS (up to 10^6 mg/l) and organics will persist for up 2 days for the first pulse of erosion (termed "Phase I" in that report), followed by slightly elevated concentrations of TSS (above 10^4 mg/l) that could persist for up to a week and would rapidly decline. For DRC-3, Phase I impacts would not occur, but "Phase II" impacts (the subsequent period of less intense erosion and delivery of fine sediment) would be broadly equivalent to those of the other two concepts.

4.1.1 Surface Water

CMWD has maintained records on the timing and volume of water diversions from the Ventura River for many years, but the data do not include information on turbidity or TSS concentrations. However, sufficient information exists to infer this information. Based on historic diversion and creek/river gage records, and using established relationships between TSS and flow, AECOM and Stillwater Sciences (2015) estimated that CMWD has historically diverted at Robles when TSS concentrations were upward of 10,000 mg/l.

It is assumed at this time that CMWD will not divert water from the Ventura River for a certain period associated with the initial flush of fine sediment from the reservoir behind Matilija Dam (i.e., during Phase I, for DRCs 1 and 2).

In the event that elevated suspended sediment concentrations persist after this period, it is possible that subsequent diversions at the Robles diversion could lead to some level of suspended sediment deposition in the Robles-Casitas Canal and associated increased maintenance. However, high diversion flows are likely to be associated with a velocity that will transport the bulk of additional fine sediment through the canal to Casitas Reservoir.

The additional quantity of sediment is likely to have a negligible impact on the overall life of Casitas Reservoir and other surface water facilities, due to the short duration of anticipated elevated suspended sediment concentrations and providers' prior experience with high TSS concentrations during which diversions have historically occurred (AECOM and Stillwater Sciences, 2015).

4.1.2 Groundwater

There is a concern that elevated suspended sediment concentrations in Ventura River could lead to a reduction in adjacent well efficiency, particularly for shallower wells near Ventura River, due to perforations plugging with silt. Concern about physical migration of finer sediments, particularly to shallower wells are not supported by current research (Cui, et al., 2008), which suggest that fine sediment infiltrates to a very limited depth, usually to within a few diameters of the largest bed material particles, rather than settling to the bottom of the alluvial aquifer.

In addition, recharge within the watershed could be impacted if fine sediments blanketed the river bottom and remained for an extended period of time. Due to the steepness of the channel, however, the *Matilija Dam Ecosystem Restoration Feasibility Study - Final Report* completed by the US Army Corps of Engineers (USACE, 2004) does not anticipate fines being deposited in the active channel. The recharge capacities are therefore not expected to be impacted.

4.2 Increased Organics

AECOM and Stillwater Sciences (2015) concluded that very high oxygen demand (associated with increased organic material concentrations) during Phase I transport under DRC-1 and 2 is likely to create severely anoxic conditions in Matilija Creek and much, if not all, of the Ventura River during those hours immediately following dam removal for which suspended sediment concentrations will also be extraordinarily high. In the following two weeks of (exponentially declining) Phase II transport, however, oxygen demand will fall rapidly to single-digit values given the rapid orders-of-magnitude reduction in suspended sediment concentrations that are anticipated to occur. At these levels, the water should be rapidly re-oxygenated by downstream transport.

DRC-3 would avoid the day of intense anoxia immediately following dam removal and likely have a reduced level of background oxygen demand contribution during the following weeks of Phase II transport as well.

4.2.1 Surface Water

4.2.1.1 CMWD

It is assumed at this time that CMWD will not divert water from the Ventura River for a certain period associated with the initial flush of fine sediment and organic material from the reservoir behind Matilija Dam (for DRCs 1 and 2). In the unlikely event that elevated organic material concentrations persist after this period, it is possible that subsequent diversions at the Robles diversion could lead to impacts to water quality in Casitas Reservoir.

Existing Issues

Excess organic material is an existing problem in Casitas Reservoir, as it nourishes algae, causes algal blooms and creates an undesirable taste, even after treatment. When the algae dies, it settles to the bottom of the lake. During summer months, the surface water temperature of the lake rises, while the deeper portions of the lake remain cool. This results in the development of a thermocline that prevents oxygen

migrating to depth. Within the oxygen-poor hypolimnion, a series of chemical reactions can result in the release of additional phosphorous, and the generation of ammonium, iron, methyl mercury, manganese and hydrogen sulfide, which result in fish kills and water treatment challenges at CMWD's water treatment plant. In addition, some recreational impacts occur from poor water quality, as algae creates color and odor issues. Chemical treatment of the algae can cause secondary impacts as additional treatment can cause additional byproducts. Figure 4-1 shows a section of a typical reservoir with temperature stratification and algae problems.

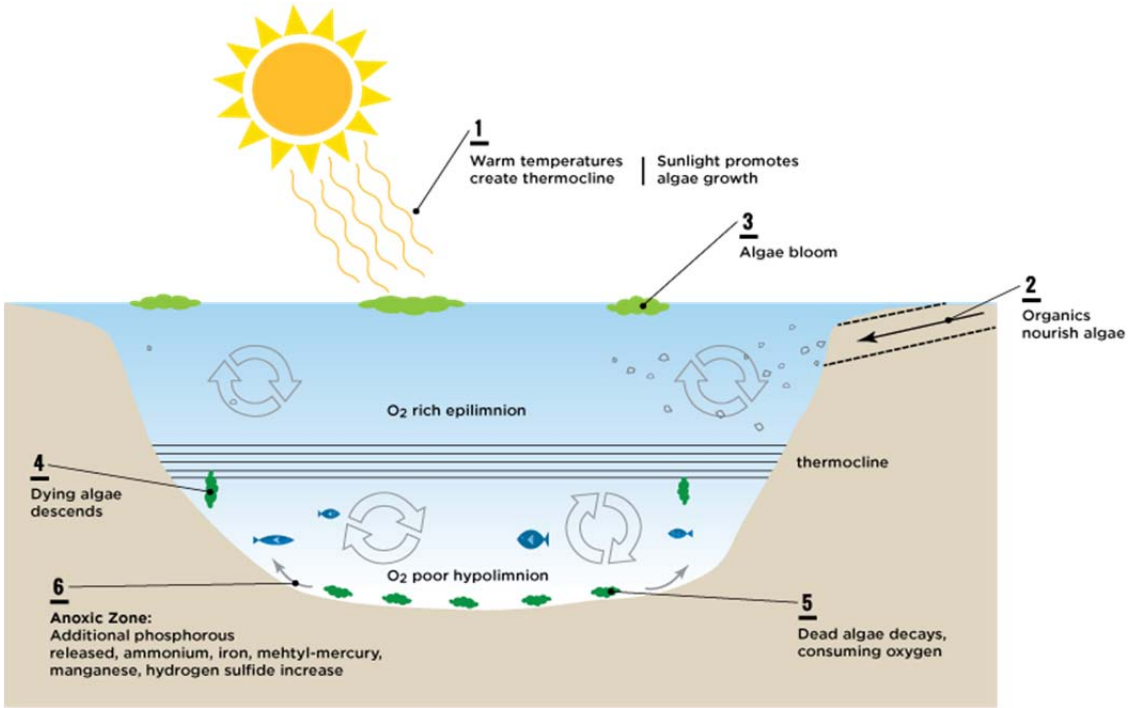

Figure 4-1: Water Quality Issues Associated with Organic Loading and Stratification

When a thermocline is present, CMWD mitigates the existing issues with water quality through careful monitoring and selection of the withdrawal depth at the inclined intake at Casitas dam. CMWD also employs a bubbler system for lake aeration to increase the range of depths over which withdrawals can be made and treats the lake with algae killers. CMWD is considering expanding the aeration system.

Potential Dam Removal Impacts

The potential incremental impacts to Casitas Reservoir from organics released at Matilija Dam are unclear, given the short duration of expected peak loading of organics following dam removal, the large total volume of the reservoir, and the existing issues with organic loading. It is assumed that CMWD will not divert water from the Ventura River during the Phase I flushing of sediment and thus that the incremental increase of organics present in Phase II diversion would represent the impact to water quality. There would also be an impact to Casitas Reservoir due to the amount of water not diverted during Phase I, as summarized in Section 2.2.

4.2.1.2 Ventura Water

The City of Ventura has subsurface intakes along the Ventura River at Foster Park. It is possible that excess organic loading during the high flow flush could result in a slightly higher intake of organics at this location. The incremental amount of loading above the background levels the City currently treats during high flows is unknown. However, the most likely scenario is that Ventura water will make a determination to cease withdrawals at this location during Phase I sediment flushing and will thus be required to take more water from CMWD during this two week period. As they already have an agreement with CMWD to meet their demands, there is unlikely to be an impact to Ventura Water's supply from downtime at Foster Park.

The water extracted from Mound Basin requires it to be blended with water from Ventura River or CMWD, prior to being delivered to customers. It should be noted that a reduction in water from CMWD and from Foster Park may also effectively reduce the supply available from Mound Basin, resulting in a compounding impact to the City's water supply.

4.2.2 Groundwater

Some providers have expressed concern about potential groundwater quality impacts from contaminants such as metals and organics in solution that could migrate into the aquifer. There is currently insufficient information to characterize the sediments behind Matilija Dam to rule out the possibility of metals, but these are not expected due to the relatively undisturbed nature of the upper watershed. As stated in USACE 2002, "in no instance do the concentrations of any analyte exceed Screening Level or Maximum Level concentrations developed under PSSDA… In that regard, based on potential contaminants only, any of the sampled material in Matilija Dam would be suitable for use on a beach or for natural release that would eventually transport it to a beach."

A higher load of organics is anticipated during the flushing immediately following dam removal. However, over a period of no more than two weeks the magnitude of oxygen demand associated with organics is expected to return to pre-project levels, with no long term impacts. Any unanticipated reduction in well efficiency of shallow wells near the Ventura River, due to modified bacteriological presence and scale buildup could be mitigated by flushing.

5.0 Mitigation Options

5.1 Types of Mitigations

There are four basic types of mitigation that were considered to manage potential impacts of the Matilija Dam removal project, additional sediment loading in the Ventura River and Casitas Reservoir, and the possible incremental loss of supply to impacted providers. These four types of mitigations are:

1. *Diversion replacement alternatives* would move water from above the Matilija Dam project area directly to Robles Diversion or Robles-Casitas Canal, thus eliminating the potential for additional sediment loading at CMWD facilities. Providers other than CMWD would not realize direct benefits from this type of mitigation;
2. *Replacement supplies* would seek new sources of water to mitigate both water quality and supply impacts. Although many of these alternatives would supplement CMWD which provides regional benefits, other replacements are also considered. The understanding behind replacement supplies is that supplies to any one of CMWD's water users frees up additional supply for other users and thus increases overall flexibility;
3. *Re-use and conservation* are, in effect, a type of replacement supply, but they are unique in their ability to truly create more available water in the system. Re-use and conservation are among the most highly adaptable alternatives, and they rate highly in terms of environmental stewardship as well; and
4. *Treatment alternatives* focus on mitigating potential water quality impacts due to projected increases in sediment loading. These alternatives would screen, filter, or even chemically remove fines and organics to prevent a variety of issues faced by water providers.

The mitigation alternatives identified by the Consultant Team and considered in this conceptual report are summarized in Table 5-1 below.

Table 5-1. Summary of Mitigation Alternative Types

Type of Mitigation	ID No.	Description
Diversion	1	Diversion from Matilija to Canal
	2	Diversion from NF Matilija to Canal
	3	Diversion from Matilija to NF Matilija to Canal
Replacement Supplies	4	Infiltration Galleries
	5	Water Transfer from SWP to CMWD
	6	Water Transfer from MWD to Casitas via Carpinteria
	7	CMWD Transfers to MOWD
	8	Groundwater Transfers
	9	Desalination
	10	New Wells in Santa Paula Basin
	11	New Well Heads at Foster Park
	12	San Antonio Creek Diversion Expansion

Table 5-1. Summary of Mitigation Alternative Types

Type of Mitigation	ID No.	Description
Re-Use & Conservation	13	Recycled Water - Ojai Valley Waste Water Treatment Plant
	14	Recycled Water - Ventura Water Reclamation
	15	Recycled Water – Scalping Plants
	16	Urban and Agricultural Conservation
	17	Crop Idling Transfers
Treatment	18	Robles Diversion Dam Improvements
	19	Robles-Casitas Canal Treatment
	20	Casitas Reservoir Oxygenation Enhancement
	21	Back-flushing of MOWD Wells 1 and 2
	22	CMWD Water Treatment Plant System Modifications
	23	CMWD Water Treatment Plant Roughing Filters

5.2 Evaluation Criteria

Each of the 23 proposed mitigation options were evaluated using the following criteria:

- *Cost* – The estimated lifecycle costs of the options were evaluated relative to each other as well as their potential for return on investment when compared with other alternatives.
- *Environmental* – This criterion considers the potential environmental impacts for each option as well as possible environmental permitting requirements.
- *Feasibility* – The feasibility evaluation represents the general effectiveness of each option in regards to mitigating potential water volume losses as well as the constructability and scheduling. Additionally it considers comments and feedback received from local agencies and stakeholders.
- *Adaptability* – The adaptability criteria considers whether the proposed option has any future benefits beyond the mitigation needs of the dam removal project.

The twenty-three mitigation options were evaluated based on the preceding criteria in order to allow recommendations to be made for further development and possible implementation. Primarily, options must be deemed feasible to be recommended for further evaluation. However, a number of alternatives were screened out based on excessive costs alone. Often, the alternatives with higher estimated costs of implementation were those where large investments in infrastructure were a requirement, regardless of the scale of the alternative. As an example, a desalination plant, regardless of location or design flow, will always be very expensive and time consuming to implement.

5.3 Description and Evaluation of Mitigation Options

The mitigation options investigated as part of this analysis are presented in Figure 5-1, by type of mitigation provided.

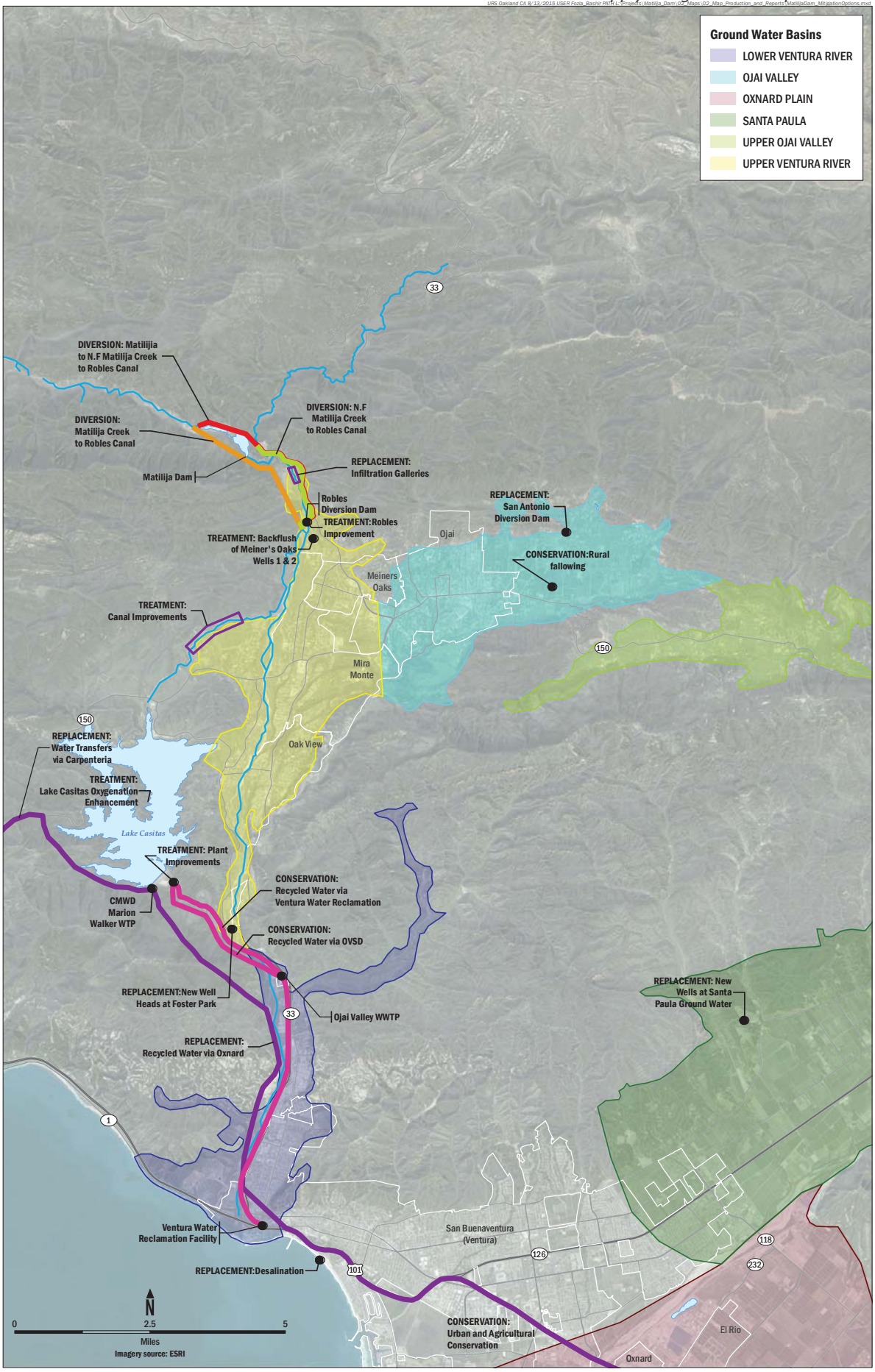

Figure 5-1: Matilija Dam Mitigation Options

5.3.1 Diversion Replacement (Full or Partial)

The Diversion Replacement options consist of diverting flows upstream of Matilija Dam to the Robles-Casitas Canal, or to North Fork Matilija Creek and down to the canal, protecting all, or part of the total instream flows that would be available at Robles from the impacts of sediment.

Three variations of the diversion replacement were considered:

- Matilija Creek Diversion to Robles-Casitas Canal;
- North Fork Matilija Creek Diversion to Robles-Casitas Canal; and
- Matilija Creek Diversion to North Fork Matilija Creek Diversion to Robles-Casitas Canal

The design criteria for the three diversion replacement options were based on the maximum flow capacity of the existing Robles-Casitas Canal, estimated at 500 cfs. By sizing the diversion pipelines for this design flow, the diversion pipelines could convey flows equivalent to the existing canal resulting in no loss in water volume to Casitas Reservoir. The required pipe diameter to meet the design flow criteria for all three sub-options is 8 feet.

The three diversion options have no utility beyond the project construction period. Once sediment and organic concentrations in the river return to typical levels, flows could be diverted through the Robles-Casitas Canal as is now the case and the new facilities would be no longer required.

5.3.1.1 Matilija Creek Diversion to Robles-Casitas Canal

This mitigation option would divert water from Matilija Creek directly to Robles-Casitas Canal. This option would require the construction of a 2.5-mile long diversion pipeline and a temporary diversion dam located upstream of Matilija Dam.

The pipeline would be constructed primarily by tunneling south from upstream of Matilija Dam to the Robles-Casitas Canal.

Evaluation

Cost – The estimated construction cost of the pipeline and diversion dam is $52.8 million (M). Due to the high estimated cost, a smaller diameter pipeline of 4 feet was also considered. This diameter represents a capacity of 125 cfs which, based on historic diversion records, would be equivalent to approximately 50% of the flow volume diverted through the Robles Casitas Canal. The smaller pipeline reduced construction costs to approximately $40M.

Environmental – The pipeline alignment is primarily within undeveloped, rural lands and requires a large tunnel. An extensive environmental review is likely required.

Feasibility – Due to the length of environmental review required, this option would be difficult to implement in a timely manner. In addition, this option would not be effective with Dam Removal Concept 1 as the removal option consists of a bypass tunnel from upstream of Matilija Dam to the North Fork Matilija.

Adaptability – Once the sediment and organic levels in the Ventura River return to typical levels, the pipeline facilities would be no longer needed.

5.3.1.2 North Fork Matilija Creek Diversion to Robles-Casitas Canal

This mitigation option would divert water from North Fork Matilija Creek, where a temporary diversion dam would allow all of North Fork Matilija Creek's flows to be diverted to the Robles-Casitas Canal. The temporary diversion dam would be located on the North Fork Matilija Creek, north of the convergence with Matilija Creek. The diversion pipeline would travel south to the Robles-Casitas Canal, following Highway 33.

The pipeline would be approximately 2.7 miles in length and be constructed through open trenching.

Evaluation

Cost – The estimated construction cost of the pipeline is $14.3M. Due to the high estimated cost, a smaller diameter pipeline of 4 feet was also considered. This diameter represents a capacity of 125 cfs which, based on historic diversion records, would be equivalent to approximately 50% of the flow volume diverted through the Robles Casitas Canal. The smaller pipeline reduced construction costs to around $8.5M

Environmental – The pipeline alignment crosses through both developed and undeveloped lands. An extensive environmental review would likely be required.

Feasibility – Due to the length of environmental review required, this option would be difficult to implement in a timely manner. The alignment traverses through public and private lands and would require approvals and easements from multiple entities, which is complex and time consuming.

Adaptability – Once sediment and organic levels in the Ventura River return to typical levels, the pipeline facilities would be no longer beneficial.

5.3.1.3 Matilija Creek Diversion to North Fork Matilija Creek Diversion to Robles-Casitas Canal

This mitigation option would divert water from Matilija Creek to North Fork Matilija Creek with a temporary diversion dam upstream of Matilija Dam and a tunnel connecting Matilija Creek to North Fork Matilija Creek, where a second temporary diversion dam would allow all of Matilija Creek and North Fork Matilija Creek's flows to be diverted to Robles-Casitas Canal

The pipeline would be approximately 3.1 miles in length and constructed through a combination of tunneling and open trenching. The tunnel is required due to a high point between Matilija Dam and the North Fork Matilija Creek. The tunnel length is approximately 1000 feet.

The diversion pipeline would travel east along the southern edge of Matilija Dam. As previously stated, a small tunneling segment will be required between Matilija and the North Fork Matilija Creek due to a high elevation point. From the North Fork Matilija Creek point, the pipeline would travel south to the Robles-Casitas Canal, following Highway 33.

Evaluation

Cost – The estimated construction cost of the pipeline is $19.4M. Due to the high estimated cost, a smaller diameter pipeline of 4 feet was also considered. This diameter represents a capacity of 125 cfs which, based on historic diversion records, would be equivalent to approximately 50% of the flow volume diverted through the Robles Casitas Canal. The smaller pipeline reduced construction costs to $13M. However, with Dam Removal Concept 1, the costs would be effectively reduced as a pipeline would already be required to North Fork Matilija Creek to implement the dam removal.

Environmental – The pipeline alignment crosses through both developed and undeveloped lands. An extensive environmental review is likely required including botanical and biological surveys along the pipeline alignment.

Feasibility – Due to the length of environmental review required, this option would be difficult to implement in a timely manner. The alignment traverses through public and private lands and would require approval and easements from multiple entities.

Adaptability – Once sediment and organic levels in the Ventura River return to typical levels, the pipeline facilities would be no longer beneficial.

5.3.2 Replacement Supply (Full or Partial)

5.3.2.1 Infiltration Galleries

Infiltration galleries or radial collection wells could be constructed along the Ventura River to collect subsurface flows for conveyance to Casitas Reservoir. Fine sediments and organics would be filtered by percolation through the surrounding soils. The percolated water would be collected and then conveyed to the Robles-Casitas Canal through a new transmission pipeline. A pump station would also be required.

The infiltration gallery would consist of two, 36-inch diameter, stainless-steel wire wrap type well screens. The initial design flow was 500 cfs, the maximum capacity of the Robles Casitas Canal. At this flow rate, the infiltration gallery could function as a complete volume replacement. However, the size of the gallery required to meet this flow rate was unfeasible (over 6 miles in length). A reduced design flow of 125 cfs was evaluated. A design criteria of 125 cfs would allow the infiltration galleries to capture 50% of the average annual diversion volume.

At 125 cfs, the infiltration gallery would be approximately 8,800 feet in length.

The infiltration galleries would be located between the confluence of Matilija Creek and North Fork Matilija and the Robles Diversion Dam to maximize the use of gravity flow to the canal.

Evaluation

Cost – The estimated cost of an infiltration gallery with a design flow of 125 cfs is estimated at $20M. An additional transmission pipeline and possible pump station would be required in order to convey the captured water to the Robles-Casitas Canal and is not reflected in the presented cost estimate above.

Environmental – The infiltration gallery would be installed parallel to the Ventura River stream bed and would require a comprehensive environmental review.

Feasibility – The environmental review, permitting, and construction period would be difficult to implement in a timely manner. Additionally, there is limited space available, making it difficult to acquire the required land area for this alternative.

Adaptability – Once the dam removal is complete and sediment and organic values return to typical levels, the infiltration gallery would no longer be required. However, the infiltration galleries could be used instead of the Robles Diversion Dam facility for reduced environmental impacts to the river.

5.3.2.2 Water Transfers

5.3.2.2.1 State Water Project

Both the City of Ventura and CMWD has the potential to obtain water from the State Water Project (SWP).). However, the lack of existing facilities and agreements, as well as the timing of water availability from SWP do not favor these alternatives.

City of Ventura

The City of Ventura has a 10,000 AFY allocation from the State Water Project. At this time, the City does not have the facilities required to deliver this water into the distribution system. The City has estimated that the cost of wheeling water through Metropolitan Water District facilities would be over $1,300/AF, not including the wheeling charges assessed by local agencies (Water Report, 2013).

CMWD

CMWD is a member agency of the SWP, with a 5,000 AF entitlement. The nearest SWP facility is Castaic Dam. In 1991, Ventura County agencies estimated that the infrastructure required to deliver water from Lake Castaic to the City of Ventura would cost approximately $120M.

There is also potential CMWD access at Carpinteria, approximately 15 miles to the north of Casitas, where a connection at the terminus of the South Coast Conduit (SCC), at Carpinteria Reservoir, would allow for connection to the State Water Project. However, the pipeline is the primary source of water for the Goleta Water District, City of Santa Barbara, Montecito, Summerland and Carpinteria Valley areas and the design and age of the system constrain the ability of the SCC to function at the system's original design capacity. In addition, the system is already suffering demand deficits. In 2014, the available water from the State Water Project was 5%, and is not likely to change in the foreseeable future. This makes the State Water an unreliable source. Coupled with the timing of Casitas' water needs, it is unlikely that sufficient supply would be available during a dry period, even after a single large storm.

5.3.2.2.2 CMWD Transfers to MOWD

Meiners Oaks Water District (MOWD) is a water purveyor in Ventura County. The District owns and operates 5 wells located near the Ventura River with an average annual water demand of approximately

1,100 AFY. MOWD currently receives water from CMWD on an as-needed basis. The volume of water transferred is relatively small, averaging less than 50 AFY.

MOWD Wells 1 and 2 are located along the Ventura River and represent 30% of the district's water production. In 2009, Daniel B. Stephens and Associates prepared an Assessment of Potential Impacts to MOWD Wells that indicated that the increase in fine sediments and organics due to the dam removal could cause deficiencies in the MOWD Wells 1 and 2 and potentially reduce the amount of water MOWD is able to extract, causing a deficit in water production and demand (Stephens and Associates, 2009). While it is unlikely that significant quantities of fines will infiltrate below a few feet in depth (Cui, et al., 2008), fines could enter the wells through an improperly sealed well head during the high flow event. MOWD has indicated concern about well head seals. The loss in water production for MOWD could be mitigated through additional transfers from CMWD.

Evaluation

Cost – CMWD sells water to MOWD at a rate of $2.30/100 cubic feet (CF) (MOWD 2014). The volume of additional water to be transferred was determined by assuming Wells 1 and 2 would be inoperable for 3 weeks out of the year, following a worst-case-scenario large storm at the beginning of the recharge season with a two week Phase I flushing period and a week of downtime before the flushing could be implemented. The deficit volume of water is estimated at 82.5 AFY. The cost of purchasing the deficit volume from CMWD is estimated at $20K.

Environmental – There are no environmental concerns with MOWD purchasing additional water from CMWD.

Feasibility – No additional infrastructure or construction is needed as CMWD currently transfers water to MOWD. The volume of water to be transferred could be scaled as needed based on the operational status of Wells 1 and 2.

Adaptability – Once sediment and organic levels in the river return to normal, the volume of water transferred from CMWD to MOWD would revert to typical volumes.

5.3.2.2.3 Groundwater Transfers

According to the California Water Code, water transfer agreements between users are desirable when they alleviate temporary local shortages. However, the process for enacting temporary transfers is potentially onerous and, particularly in a time of drought, is unlikely to be approved, as there is unlikely to be sufficient water available for a transfer to occur without impact to the existing users. The State has prepared a white paper explaining the basic requirements for implementation of water transfers. This white paper (CDWR 2014) indicates that:

> "…water can be transferred … if the State Water Resources Control Board can make the following findings: (1) the proposed transfer would not injure any legal use of the water, during any hydrologic condition and (2) the proposed temporary water transfer would not unreasonably affect fish, wildlife, or other instream beneficial uses. If the SWRCB cannot make the above findings within 60 days, it is to notice and subsequently hold a hearing. The 60 day time period can be extended if approved by the permittee or licensee.

> The time required to hold a hearing would delay most temporary transfers to the point that they could not take place in the year proposed."

The only scenario in which is it possible that groundwater could be transferred out of one of the nearby groundwater basins, such as Ojai, is one where recent precipitation has allowed the groundwater to recharge, but reservoir levels have not yet recuperated from the drought. However, all local groundwater basins are sufficiently depleted at the time of this memorandum that this alternative was considered to be infeasible. In the event that the project is implemented during a wet cycle instead, the alternative will not be needed, as there is likely to be sufficient water in Casitas Reservoir to meet needs.

5.3.2.3 Desalination

In this option, a new desalination plant would be constructed to replace the lost diversion volumes due to the increased sediment and organics load from the dam removal. A desalination plant was sized at 5 MGD, would be equivalent to 50% of the average annual diversions that Casitas Reservoir receives through the Robles-Casitas Canal.

The desalination plant would require an open ocean intake and would require new transmission infrastructure to convey the water to the existing distribution system.

Evaluation

Cost – The estimated cost of the desalination plant is $65M. This cost does not include the transmission facilities that are required to connect the plant to the distribution system

Environmental – A new desalination plant would present significant environmental concerns and be subject to an extensive environmental review.

Feasibility – Due to the environmental permitting required, the construction of a new desalination plant would be difficult to implement in a timely manner.

Adaptability – The desalination plant would continue to operate after the dam removal project is complete and function as an additional water source. Water production from the plant is not subject to local hydrology and as such would provide a measure of drought protection and the additional supply is moved to the combined City-Casitas service area.

5.3.2.4 New Wells in Santa Paula Basin

CMWD provides approximately 5,000 AFY of supply to the City of Ventura. Any additional supply for the City of Ventura would result in reduced demand for CMWD water and is therefore equivalent to an additional supply for CMWD.

The City of Ventura has an entitlement of 3,000 AFY from the Santa Paula Basin however the City's existing wells only have a capacity of 1,600 AFY, leaving a potential additional available supply of 1,400 AFY. In order to extract the additional 1,400 AFY entitled to the City of Ventura, a new well would need to be constructed.

Evaluation

Cost – The construction cost of a new well with an average capacity of 1,400 AFY is estimated at $250K. There will be an additional cost to connect the well to the existing transmission system. The cost for the connection will depend on the location of the well and nearby infrastructure and is not considered in the presented cost above.

Environmental – No significant environmental issues are anticipated with the well construction. The City of Ventura currently operates wells that extract water from the Santa Paula ground water basin. However, the Fox Canyon Groundwater Management Agency has rejected administrative and legal attempts by the City to increase its extraction from the basin. In addition, legal action is currently pending regarding overdraft of the Oxnard Plain Groundwater Basin.

Feasibility – This option would require a new well to be drilled and new wellhead constructed and could be completed prior to the dam removal. The option is equally beneficial for all dam removal concepts.

Adaptability – The new well would function as additional water supply for the City of Ventura and could be used beyond the dam removal as the City is not currently using their entire water entitlements. The increased production would allow for additional operational flexibility in the future.

5.3.2.5 New Well Heads at Foster Park

The Foster Park Facilities divert water from the Ventura River via a surface and subsurface water intake owned and operated by the VCWPD. Surface water from the Ventura River is collected via surface diversion, subsurface collector, and shallow wells. Groundwater is extracted from the Upper Ventura River Groundwater Basin via a series of wells.

As part of the Matilija Dam Ecosystem Restoration Project, two additional wells, identified as Wells No. 12 and 13, were installed at Foster Park as part of the mitigation measures of the dam removal. The wells were constructed and funded through a grant received by the VCWPD for the City of Ventura in order to mitigate potential water lost as a result of increased turbidity. However, the wells were never completed. While the wells have been drilled, wellheads have not been constructed and therefore the wells are not currently operational. The wellhead design is reportedly 90% complete.

Evaluation

Cost – The estimated cost of the two new well heads based on the current 90% design plans is $1.5M. However, there may be potential cost savings by eliminating certain proposed project features in the current design, such as a SCADA system, which may not be needed for temporary mitigation purposes.

Environmental –The wells have already been drilled and only require construction of the well heads. No environmental permitting is expected for production in regards to mitigation for dam removal. However the Santa Barbara Channel Keepers has recently filed a lawsuit against the State Water Resources Control Board over the City of Ventura's take of water at Foster Park The lawsuit seeks to compel the State Water Board to perform a Reasonable Use Analysis of the City of Ventura's extraction from the Ventura River.

Feasibility – The wells have already been drilled and the City currently has 90% design plans for the construction of the wellheads and regulatory permits. It is likely the project could be completed and the wells brought online prior to the dam removal.

Adaptability – The original purpose of the wells was specifically for mitigation purposes for the removal of Matilija Dam. However, the wells could be converted to production wells for the City once the dam removal project is completed, with limitations on extraction dependent on the City's water rights. Re-purposing the wells for alternate production would likely require further environmental and regulatory review.

5.3.2.6 San Antonio Creek Diversion Dam Expansion

The San Antonio Creek Spreading Grounds Rehabilitation Project was intended to reduce reliance on imported water supplies from CMWD through increasing the groundwater storage and recharge in the Ojai Basin by diverting surface water from the San Antonio Creek into a series of infiltration ponds and recharge wells. The project stakeholders are composed of the Ojai Basin Groundwater Management Agency, the Ojai Water Conservation District, the Golden State Water Company, the Casitas Municipal Water District and the Ventura County Watershed Protection District. The project was completed in July 2014.

This option considers the expansion of existing facilities to divert additional water from San Antonio Creek and convey the water to Casitas Reservoir via the Robles-Casitas Canal. The option assumes the maximum diversion rate is 25 cfs, identical to the existing diversions to the recharge ponds. The pipe diameter required to meet the design flow rate is 24 inches. The pipeline would be approximately 6.5 miles long and travels along existing roadways following mainly Highway 150 and Highway 33.

There may be potential customers in the Ojai Basin which are closer to the diversion site. The existing infrastructure and connection points would need to be confirmed. If diversions can be delivered to nearby customers, there could be a reduction in costs as a result of a shorter pipeline. However, it is likely that diversions from the creek will only be available during the winter seasons when demand is typically lower. In addition, there is minimal system storage available in the Ojai Basin region. As such, the actual reduction in water demand mitigation may be less than expected.

Evaluation

Cost – The cost of the transmission pipeline is estimated at $17M.

Environmental – The project would require a comprehensive environmental review as the San Antonio Creek is the main sub-watershed for steelhead refuge. Additionally, the 25 cfs in the current design is only available during a 100-year storm. In order to be useful in offsetting the effects of dam removal, the diversion would need to be modified to capture more storm flows, which would require new permits. The increased diversion may also reduce the supply available for downstream intake facilities, such as Foster Park.

Feasibility – The right of way acquisition and environmental permitting would be a lengthy process and be difficult to implement in a timely manner. The 25 cfs in the current design is only available during a 100-year storm event which would not produce a significant volume of water.

Adaptability – Diverting San Antonio Creek flows to Casitas Reservoir would provide an additional water source and provide CMWD with additional operational flexibility. The continued use and volume available for diversion would likely depend on requirements for the Steelhead habitats and that the increased diversions do not negatively impact the recharge of the Ojai Groundwater Basin.

5.3.3 Re-use and Conservation

5.3.3.1 Water Re-use

5.3.3.1.1 Ojai Valley Waste Water Treatment Plant

The Ojai Valley Waste Water Treatment Plant (WWTP) is operated by the Ojai Valley Sanitation District (OVSD) and serves 20,000 residents of the City of Ojai. The plant receives average flows of 1.55 MGD. There have been discussions about implementing a recycled water program to supply customers with recycled water, reducing the demand of potable water. Currently, the tertiary treated water is discharged to the Ventura River to enhance Steelhead habitat and thus, could not be used for mitigation purposes, making this option infeasible if the additional supply is moved to the combined City-Casitas service area

While the plant does not currently serve any recycled water customers, and existing agreements prohibit this, a 2007 Re-Use Feasibility Report (Stoecker Ecological 2007) identified potential customers currently supplied with domestic water from the City of Ventura that could be converted to recycled water, thus freeing up approximately 1,000 AFY of domestic water for distribution to the City's customers.

The City of Ventura currently leases the WWTP land to OVSD. As part of the agreement with the City OVSD would be expected to deliver any recycled water to the City, should the existing mandate for Steelhead be altered.

This option involves modifying the project permits to divert some of the recycled water away from Steelhead habitat enhancement and for use instead by City customers, including constructing distribution pipelines to those customers.

Evaluation

Cost – The costs associated with this option are based on the construction of new distribution pipelines to deliver recycled water to customers. The cost per mile of pipe is estimated at $300 per lineal foot (LF). The length and alignment of the pipelines depends on the location of the potential customers. A recycled water program may be eligible for state grants.

Environmental – There are no direct environmental concerns with supplying customers with recycled water. However, the OVSD discharge permit currently requires all effluent to be discharged to the Ventura River for fish habitat. An environmental review would be required to ensure that reducing the volume of discharges to the river does not cause a detrimental effect to the local biology.

Feasibility – The OVSD WWTP currently treats water to tertiary levels which is sufficient for customer use and so construction would be limited to transmission pipelines. A recycled water distribution system

could likely be completed and online to meet the dam removal schedule. In addition, a potential demand for recycled water has been previously identified.

Adaptability – Developing a recycled water demand would remain useful after the dam removal project is completed. Substituting recycled water for existing water supplies will reduce the City's reliance on surface and subsurface diversions and provides a measure of drought protection.

5.3.3.1.2 Ventura Water Reclamation Facility

The Ventura Water Reclamation Facility is a tertiary wastewater treatment plant which provides wastewater treatment services to 98% of City residences in addition to wastewater services for McGrath State Beach Park and the North Coast Communities. The tertiary plant is located in the Ventura Harbor area near the mouth of the Santa Clara River.

Average annual flows to the facility total approximately 9 MGD, with a total capacity of approximately 12 MGD. Currently, the City has a small recycled water demand at 700 AFY. The recycled water customers consist of two golf courses, a City park, and landscape irrigation areas along the existing distribution alignment. The remaining effluent is discharged to the Santa Clara Estuary.

Expanding the recycled water customer base would reduce the amount of water that CMWD supplies to the City resulting in increased water supply for CMWD.

This option would consist of expanding the tertiary treatment plant and construction distribution pipelines to new customers.

Evaluation

Cost – The City of Ventura has existing infrastructure for delivering recycled water to customers. Expanding the recycled water program consists of constructing water pipelines to new customers. The estimated cost of the pipeline is $4300 per LF. Grants may be available for expanding the recycled water program.

Environmental – Environmental concerns are limited to the effects of lower volume of discharges to the Santa Clara River Estuary. A biological review will be required to determine the lower volumes do not harm the local wildlife.

Feasibility – The City already serves several customers. Expansion of the system entails identifying new customers and construction of additional pipelines to convey the recycled water. If users could be identified near the treatment facility, deliveries could likely be initiated in a timely manner.

Adaptability – Expanding the City's recycled water customer base has benefits beyond the dam removal by reducing the City's reliance on surface/subsurface diversions which provides a measure of drought protection.

5.3.3.1.3 Scalping Plants in Ojai Valley

Scalping plants are small-scale wastewater treatment systems that produce recycled water by intercepting a portion of the influent in sanitary sewer mains. The wastewater is treated locally and then delivered to

customers. In scalping plants, only the liquid waste is treated. The solid waste is returned back to the sewer main for treatment at the local wastewater treatment plant. Because the waste water is treated locally, there is potential to reduce infrastructure costs related to piping and pumping. However, in order to produce a useable volume of recycled water, the scalping plants are required to be located in areas that generate sizeable amounts of wastewater.

The 2013 Sustainable Water Use in the Ventura River Watershed Report (Bren School of Environmental Science & Management, 2013), identified two golf courses in Ojai that could potentially be served with recycled water from scalping plants. The recycled water demand from the two golf courses is estimated at 220 AFY.

This option considers construction of a new scalping plant to produce recycled water to meet irrigation water demands at two golf courses in Ojai.

Evaluation

Cost – The 2013 Bren report estimates construction costs of a 224 AFY capacity scalping plant at $2M. Annual operations and maintenance costs are estimated at $210K. This does not include any costs associated with permitting, land acquisition or additional required infrastructure.

There may be also added costs at the OVSD WWTP. As scalping plants only treat liquid waste, the concentration of the influent to the OVSD WWTP may change and potentially require modifications to treatment and/or operations.

Environmental – Currently, all effluent from the OVSD WWTP is discharged to the Ventura River for fish habitat. A scalping plant intercepts influent that would normally be delivered to the treatment plant, resulting in lower effluent discharge volumes. The reduction in discharge volumes from the OVSD WWTP would require approval from regulatory agencies.

Feasibility – The location of the scalping plant requires specific site conditions in order to optimize operations. The site would need to be located near a sanitary sewer force main that meets the volume requirements of the scalping plant. Additionally, the site should ideally be located near the golf courses to minimize the amount of new infrastructure required to deliver the recycled water.

Adaptability – The scalping plants could remain in operation after the dam removal. The use of recycled water is a sustainable practice and provides a measure of drought protection. Conservation Measures

5.3.3.1.4 Urban and Agricultural Conservation

A main concern of the dam removal project is a loss in water volume to Casitas Reservoir during fine sediment flushing. Implementing water conservation policies would reduce demand, which is equivalent to increasing water supplies. Recent emergency drought measures are striving to reach 15-30% demand reduction in Ventura County. If local water districts are successful in implementing a conservation strategy that reaches a portion of that goal, those same measures could potentially be extended to help mitigate the potential impacts associated with dam removal. This option evaluates potential water conservation methods and their effectiveness for the City of Ventura and CMWD.

City of Ventura

Based on the City of Ventura's 2010 Urban Water Management Plan (Kennedy/Jenks 2011), the City has employed several urban conservation incentives such as: rebates for high efficiency appliances, tiered water rates, and educational programs. The City has seen a 7% decrease in water demand per year since the implementation of the conservation plan, and it estimated that further savings could occur with additional incentives.

The City has recently developed a new conservation program called The Water Wise Incentive Program that is set to launch in July 2015. The program offers monetary incentives for replacing high water use landscaping with water saving landscapes and measures.

The City has no agricultural customers so demand reductions within the City's service area are not possible through agricultural conservation programs.

CMWD

CMWD has a small urban demand and has employed similar conservation methods to the City of Ventura. While both the City of Ventura and CMWD have already enacted water conservation plans, increasing the awareness of the conservations programs available may lead to additional water savings.

CMWD has also implemented policies for agricultural efficiencies such as rebates for smart irrigation controllers and educating agricultural customers on improving irrigation distribution uniformity and irrigation scheduling.

Evaluation

Cost – The estimated cost is $100K and represents a grant to the City and CMWD for costs related to promotion of the existing water conservation programs. In addition, new programs could be developed to augment existing programs; such as requiring new, water efficient appliances whenever a home is sold. The reduction in water usage due to conservation would cause a loss of revenue in water sales. The loss in water sales is estimated at $91,000[1]

Environmental – There are no environmental concerns with this option. This alternative would represent an environmental benefit.

Feasibility – Conservation programs have already been enacted. The option proposes increasing promotion and awareness of the programs through marketing in order to increase the adoption rate.

Adaptability – Expanding the urban conservation plan has benefits beyond the dam removal project. Reducing the average annual demand of water will allow the City and CMWD to maintain a higher surplus of water and allow for greater operational flexibility, especially in times of drought.

[1] This value is based on an estimated additional conservation of 250 AFY between City of Ventura and CMWD. The water rate was estimated at $0.831 per hundred cubic feet (HCF) as shown in the CMWD 2010 Urban Water Management Plan.

5.3.3.1.5 Crop Idling Transfers

Crop idling, or crop fallowing, allows water previously allocated to irrigation to be used for other purposes. The loss of any crops, or potential crops during the fallowing period represent the cost of the mitigation, as no new infrastructure is needed to move water. The value of the mitigation would lie in the total amount of water that was not used for irrigation during the fallowing period.

Since idled crops and re-allocated usage related to the Matilija Dam removal project would be contained entirely within Ventura County, and no State of Federal water would be involved in the transfer, Project Agency approval is unlikely to be required. Developing, reviewing and approving water transfers is often a lengthy process and it is uncertain whether there would be legal ramifications to crop fallowing, but it seems likely that this would be a feasible alternative.

Truck crops are crops that are typically replaced at the end of their productive season, at least annually. Fallowing such crops requires at most a one-year commitment of the land, as the crops could be re-seeded the following growing season. CMWD provides water service to approximately 5,700 acres of irrigated lands which consists primarily of avocado and citrus orchards, and a limited amount of truck crops such as flowers, strawberries, apples and walnuts. Orchards are a high value, long term investment crop, and thus, only orchards near the end of their productive life would be acceptable as a Matilija Dam removal mitigation option. If applied toward mitigation, the trees would be fallowed and the farmer reimbursed for the reasonable market value of the crop for that year and all subsequent years for the estimated remaining productive life of the trees. In addition, an annual lease of the land would be required to offset the lost opportunity for the farmer to replace the crop.

Without a current and detailed land use survey, it is difficult to determine what percentage of the estimated acreage of orchards could be considered near the end of their useful life, but it was assumed that no more than 10% of the total land in orchards would likely be available to fallow. Likewise, different crops have different values. For the purposes of this evaluation, a unit value for avocados, with a value of $1,850 per ton (Ventura County, 2014) was selected as this is the highest value crop grown in the area and thus provides a conservative cost estimate.

Evaluation

Cost – The estimated cost for crop idling orchards near their end of useful life is $5.95M. This cost is based on the assumption that 10% of the total irrigated land acreage in CMWD is available for idling. The cost assumes a sufficient storm occurs within one year of crop idling. A delay between when crop idling commences and when a storm event occurs may increase the costs of this concept.

Environmental – There are no environmental concerns regarding crop idling.

Feasibility – A primary concern of this option is scheduling of crop idling in relation to the dam removal. The dam removal concepts are dependent on specific storm events occurring. Due to difficulty in predicting the required storm event, a scenario may occur where crops are idled, but a sufficient storm event does not occur and the dam removal does not proceed.

Adaptability – Due to the high costs associated with this option, crop idling would not be continued as a water conservation method after the completion of the dam removal. However, there would be no unused infrastructure remaining at the end of this option.

5.3.4 Treatment Technologies

Treatment technologies consist of options to mitigate any unanticipated long-term increases in fine sediments and organics through the use of chemicals and/or filters.

5.3.4.1 Robles Diversion Dam Improvements

CMWD has begun investigating the placement of new screens at the Robles Diversion Dam. The goal of screen improvements would be to provide decreased maintenance, and more reliable removal of debris and organics from Ventura River diversions. The additional screening could aid in the reduction of organic loading to Casitas Reservoir.

The new screens being evaluated are an engineered polymer traveling screen made by Hydrolox and have less porosity than the existing screens. The smaller total amount of opening (40 % open compared to the existing screens, which are 49% open) could reduce diversion flow capacity. The Biological Opinion provides for a screen opening of 1.75 mm and would therefore be more effective at screening larger objects such as fish and debris than suspended and fine organics.

Evaluation

Cost – The cost for this option consists of the purchase and installation of new screens. From the Robles Diversion Dam Fish Screen and Fishway Project Design Plans (Borcalli and Associates, 2004), the approximate area of the screens is 5,200 square feet. The cost estimate assumes that no modifications to the channel would be necessary and that the screens could simply be replaced in the current configuration. Structural modifications may be required to insure a minimum of 621 cfs can pass through the screens during peak flow events. At an approximate cost of $31/square foot, it is estimated that including shipment and labor, this alternative would cost approximately $350k.

Environmental – There would not be any significant environmental concerns as this option replaces existing infrastructure. The Hydrolox screens may have some advantages for fish, due to the smaller opening size which is more effective at fish exclusion and a possible reduction in impingement mortality over standard screens. Modifications to the existing fish screen system would require the approval of the United States Bureau of Reclamation, National Marine and Fisheries Service, and the California Department of Fish and Wildlife.

Feasibility – It is unclear what the rate of organics removal would be from the new screens, given that little is known about the nature of the organics that could be stored behind Matilija Dam. The new screens could be very effective at removing larger organic particles, and there is some evidence that the spray bar design could be effective at removing debris and organic sludge buildup. Further explorations of the sediment behind the dam would be needed to further evaluate this alternative's potential effectiveness.

Adaptability – The use of screens is part of existing standard operations and will continue to be used. The new screens would likely result in lowered maintenance costs, less fouling, and thus, a more consistent performance and supply.

5.3.4.2 Robles-Casitas Canal Temporary Treatments

Improvements to the Robles-Casitas Canal would consist of the construction of treatment facilities on Federal land along the canal to allow chemical flocculation and settlement of fine sediments and organics. The fines and organics would settle out while traveling through a series of settling basins, thus reducing the amount of fines and organics entering Casitas Reservoir. In addition, access roads would be constructed to allow removal of settled material, as needed during the dry season.

CMWD has experience with the use of flocculants along the canal. In 1985, a local wildfire burned the land adjacent to the canal, producing winter storm runoff to the canal with a significant amount of organics. CMWD employed a temporary polymer floc station to treat the runoff at the canal. CMWD indicated that the success of the floc stations was difficult to quantify. In addition, the flocculants have a short shelf life, requiring them to be replaced annually, which would result in significant waste, since large events do not occur on an annual basis. The chemical flocculants would routinely expire without being used.

Evaluation

Cost – The cost of this option is estimated at $1M for initial capital improvements consisting of temporary settling basins and pumps, road improvements and $100K annually for costs to lease the Federal land, additional operations personnel and chemical flocculants.

Environmental – No significant environmental issues are anticipated. CMWD has previously used flocculants along the canal.

Feasibility – Managing the inventory of chemical flocculants would be difficult due to the short storage life of the chemicals and the difficulty in predicting storm events. This may result in large volumes of chemical flocculants expiring as they need to be made readily available for use during a storm event.

Adaptability – Adding flocculants to the canal would be performed with temporary stations along the canal as CMWD had previously done. Once the sediment and organics levels in the river return to typical values, the floc stations and settling basins could be removed.

5.3.4.3 Casitas Reservoir Oxygenation Enhancement

The additional influx of organics due to the Matilija Dam Removal causes concerns of low dissolved oxygen (DO) and iron levels in Casitas Reservoir. Low DO in the lake creates increased concentrations of manganese, hydrogen sulfide and methyl-mercury which may hamper Casitas' ability to maintain water quality standards and creates taste and odor issues

DO levels could be increased through an oxygenation system that injects oxygen into the lake. In 2013 CMWD contracted with Water Quality Solutions to provide a feasibility study for hypolimnetic oxygen system enhancements (Water Quality Solutions 2013). The study concluded that a diffused oxygen

system with up to four in-lake diffusers, a liquid oxygen delivery system and associated storage facility presented the most cost effective solution. The hypolimnetic oxygenation system would target the anoxic water below a depth of 483 feet to operate in conjunction with the existing bubbler system.

The average age of water in Lake Casitas is estimated at 10 years. As such, the organic material will reside in the lake for some time before the treatment plant sees any impacts of the additional organic loading. Mitigation options involving treatment of the lake should take this into consideration.

The hypolimnetic aeration system is under construction with 3 in lake diffusers. It is anticipated that additional liquid oxygen will be required because of the increased organic loading.

This mitigation option proposes support of the operating costs of the expanded oxygenation system presented in the feasibility study to mitigate the additional losses in DO and target DO concentrations of no less than 3 mg/L. A fourth diffuser line may also be needed.

Evaluation

Cost – There is a lack of available information on both background levels of organics and the transport of sediments and organics within Casitas Reservoir that would allow a detailed evaluation of the impacts of the incremental increase in TSS and organics due to the dam removal. This alternative assumed that low DO effects would last 2 weeks after Robles was reopened after the two-week closure for Phase I flushing. The 2013 feasibility study estimated the annual costs of a dissolve oxygenation system at $112K. The cost estimate for this option is based on the scaling the annual cost for 2 weeks, the assumed impact duration. The cost estimate to operate the dissolve oxygenation system is $5K. The preceding cost estimates do not consider the construction of a fourth diffuser.

Environmental – There are no significant environmental concerns with this option. CMWD already owns the property on which the treatment system would be placed, adjacent to the dam. Low DO can result in a variety of environmental issues and thus increasing the DO levels is generally considered a benefit for the local ecosystem.

Feasibility – The 2013 Feasibility Study concluded that the diffused oxygenation system could be effective in increasing lake dissolved oxygen levels. The latest version of the aeration de-stratification system was installed in 2005 and remains in operation.

Adaptability – CMWD has experienced low DO issues in the lake over the previous years due to warm seasonal conditions that promote the development of a thermocline, as well as the existing issues with naturally occurring organics. The concerns are more prevalent during the late summer and fall seasons. Use of the expanded oxygenation system could be continued even after the dam removal project and may allow the lake to maintain more consistent DO levels throughout the year.

5.3.4.4 Back-flushing of Meiners Oaks Wells 1 and 2

MOWD has expressed concerns that the increased fine sediment and organic loads from the dam removal will have negative impacts on the efficiency of Wells 1 and 2 due to fine material becoming lodged in them through unsealed well casings and resulting bacteriological presence and scale buildup on well casing perforations.

Wells 1 and 2 represent 30% of the MOWD water supply. A reduction in the efficiency of these wells would represent a significant decrease in water supply for this provider. The deficit would require additional water transfers from CMWD to MOWD at a higher rate (as discussed in Section 5.3.2). The need to supply this additional water to MOWD would also reduce CMWD's available supply.

Well efficiency could be maintained through a back-flushing operation to dislodge material buildup and organic growth on the well casings following the Phase I flushing event, should the wells be impacted. Back-flushing consists of sending highly pressurized water in the opposite direction of water extraction for approximately 30 minutes. No additional infrastructure is needed as back-flushing is currently part of MOWD standard operations.

Evaluation

Cost – The estimated cost for one back-flush service for each well, plus swabbing to remove scale is $20K, based on the additional hours for operations staff and volume of water used.

Environmental – There are no environmental concerns as well back-flushing is performed as part of standard operations.

Feasibility – There is no new infrastructure or operations adjustments required for this option. The back-flush could be performed on an as-needed basis based on the amount material buildup on the well casings.

Adaptability – Back-flushing is already routinely performed and is an effective method for removing buildup. The additional back-flushing would only be necessary once, following the two week period of Phase I flushing, should the wells be impacted. This mitigation alternative is completely flexible, as it would only need to be performed if it was discovered the wells had been impacted during the Phase I high flow event and there is no new infrastructure required. If there was no impact to the wells, the extra flushing would not need to be performed.

5.3.4.5 CMWD Water Treatment Plant Improvements

The CMWD Marion Walker Water Pressure Filtration Plant treats water from the Casitas Reservoir for potable use. The plant has a maximum capacity of 100 cubic feet per second (cfs) but averages 56 cfs. CMWD has expressed concerns that the increased fine sediment and organic loads will have a significant impact on water quality that could make the water more difficult to treat. While CMWD is already diverting water at high TSS concentrations, and is not expected to divert during the peak flows of Phase I flushing associated with high loading, these options address different improvements to the water treatment plant so that it could accommodate and effectively treat the water during higher sediment and organic loads than it presently does.

5.3.4.5.1 System Modifications

Based on a review of the Plant Process Flow Diagram (Sverdrup Civil, Inc. 1995), improvements to operations and system modifications could be made that would allow the water treatment plant to maintain the required water quality levels.

Because the filtration plant is capable of treating a maximum of 100 cfs but averages 56 cfs, the filtration plant could potentially remove additional turbidity and/or TSS concentration and maintain averages of approximately 56 cfs with similar water quality. Operations would be similar with the possible exception of additional flocculation chemicals, back-wash cycles, and/or sludge volumes from higher turbidity levels.

If a higher water quality was proved to be necessary due to higher turbidity and/or TSS concentration, system modifications could convert the filtration plant to a double pass from the current single pass. The system modifications would include additional instrumentation, piping, fittings, valving, and PLC or SCADA updates. High turbidity incidents would be registered by the filtration plant inlet inline turbidity meter and could automatically convert the plant to a double pass system. Figure 5-2 below presents a schematic of the new piping and automatic valves (in red) to convert the existing system to a double pass filtration plant. The filtration plant performance and capacity will depend on the influent turbidity and TSS concentration and have to be tested; however it will be less than the current maximum capacity of 100 cfs. Additional study and performance tests would be required to determine whether the system modifications can meet peak demands.

The filtration plant could convert back to single pass after high turbidity incidents. All other system operations would be similar. Additionally, higher turbidity may require additional flocculation chemicals and backwash cycles and/or generate additional sludge volumes. The current filtration media could be retained.

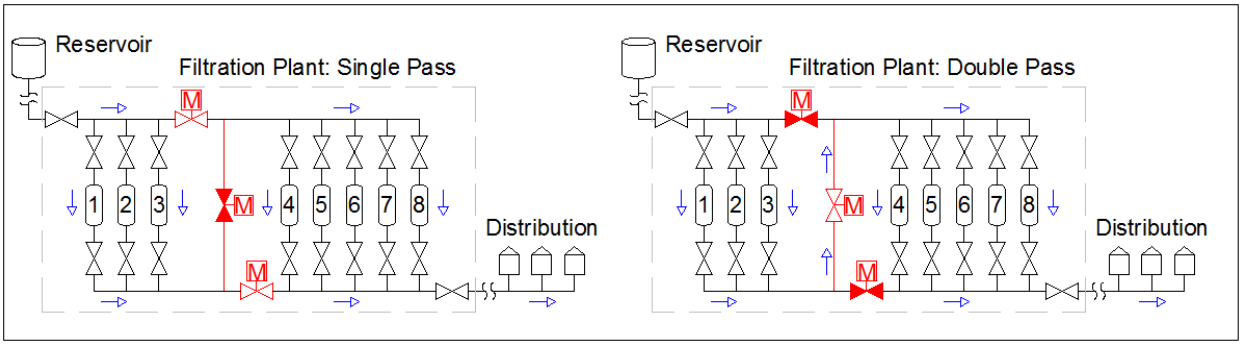

Figure 5-2: Schematic of Modified Filtration Plant with Double Pass

Evaluation

Cost – The estimated cost for improvements to the treatment plant is an initial expense of $100K for one-time plant improvements and $10K per year for additional chemicals and operations staff.

Environmental – There are no environmental impacts as the option only modifies existing operations.

Feasibility – Improvements to the water treatment plant would be effective for all dam removal concepts. The required system modifications consists of instrumentation upgrades and do not require lengthy construction times.

Adaptability – The system improvements do not require any additional maintenance and would provide the plant additional flexibility in treating high turbidity flows.

5.3.4.5.2 Adding Roughing Filters

Roughing filters are a passive water pretreatment and/or treatment technology. It is effective against suspended solids, organics, and pathogen removal. This option involves adding roughing filters to the water treatment train at the plant.

Roughing filters are typically a series of open-top, connected rectangular structures containing different filtering materials. Water flows from one compartment to an adjacent compartment through progressively finer filtering materials. There are typically three compartments of filtering materials: coarse, medium, and fine. The compartments could be arranged in a vertical up or down flow, or a horizontal flow.

The filter performance and flow rates are determined by the filtration material sizes and cross-sectional area of the compartments. For a given system, decreasing the filtration material sizes will increase water quality but decrease flow rates. To offset the reduced flow rates, the compartment sizes could be increased to maintain flow rates with a higher water quality.

The influent hydraulic head is utilized to drive the water through the filter. The head loss across the filter is designed to be relatively low to prevent water from overtopping the open compartments. The filter and compartments will require periodic backwashing to maintain quality and performance.

Evaluation

Cost – A cost estimate was developed for two flow rates: 56 and 100 cfs representing the current average flow of the plant and the maximum capacity of the plant. The construction cost is estimated at $12.8M and $21.8M respectively. These costs represent a new pressure reducing station, roughing filter structure, filter material, pump station, miscellaneous piping and electrical service upgrades.

Environmental – There are no environmental concerns with this option. The improvements will be constructed at the existing water treatment plant facility.

Feasibility – New roughing filters would be effective in mitigating the increased fine sediments and organic loads. The facilities could be constructed to meet the dam removal schedule and are equally useful for all dam removal concepts.

The water treatment plant currently utilizes the Casitas Reservoir head at approximately 120 psi to drive water across the existing filters and into the distribution system. Adding a new roughing filter pretreatment would require the Casitas Reservoir head to be significantly reduced to near or slightly above atmospheric pressure at the inlet of the roughing filter. After pretreatment, the roughing filter effluent would require boosting back to approximately 120 psi to drive through the filtration plant and into the distribution system.

Due to the existing plant set up, a new pressure reducing facility is required to reduce the Casitas Reservoir head prior to entry into the roughing filters and a new pump station after the roughing filters to boost the pressure of the roughing filter effluent back to the Casitas Reservoir head. While this setup is possible it is rather costly and inefficient.

Adaptability – The new roughing filter facilities could remain operational after the dam removal project is complete. The additional pretreatment would provide CMWD additional flexibility in operations and maintaining water quality standards.

5.4 Evaluation matrix

The following matrix presents a summary of the options evaluation and the recommendations for which mitigation options should be developed for further analysis.

Table 5-1. Evaluation of Mitigation Alternatives

Type of Mitigation	Description	Cost	Environ.	Feasibility	Adapt.	Develop Further
Diversion Replace.	Diversion from Matilija to Canal	✗	✗	✗	✗	
	Diversion from NF Matilija to Canal	✗	✗	✗	✗	
	Diversion from Matilija to NF Matilija to Canal	✗	✗	✗	✗	
Replacement Supplies	Infiltration Galleries	✗	✗	✗	✗	
	Water Transfer from SWP	✗	✓	✗	✓	
	Water Transfer from MWD to Casitas via Carpinteria	✓	✓	✗	✓	
	CMWD Transfers to MOWD	✓	✓	✓	✓	☑
	Groundwater Transfers	✓	✓	✗	✗	
	Desalination	✗	✗	✗	✓	
	New Wells at Santa Paula Basin	✓	✓	✓	✓	☑
	New Well Heads at Foster Park	✓	✓	✓	✓	☑
	San Antonio Creek Diversion Expansion	✓	✓	✗	✗	
Re-Use & Conservation	Recycled Water – Ojai Valley Waste Water Treatment Plant	✓	✓	✗	✓	
	Recycled Water – Ventura Water Reclamation	✓	✓	✗	✓	
	Recycled Water – Scalping Plants	✓	✓	✗	✓	
	Urban and Agricultural Conservation	✓	✓	✓	✓	☑
	Crop Idling Transfers	✓	✓	✓	✗	☑
Treatment	Robles Diversion Dam Improvements	✓	✓	✗	✓	
	Robles-Casitas Canal Treatment	✓	✓	✗	✗	
	Casitas Reservoir Oxygenation Enhancement	✓	✓	✓	✓	☑
	Back-flushing of Meiners Oaks Wells 1 and 2	✓	✓	✓	✓	☑
	CMWD Water Treatment Plant System Modifications	✓	✓	✓	✓	☑
	CMWD Water Treatment Plant Roughing Filters	✗	✓	✗	✓	

6.0 Recommendations

Some of the dam removal concepts currently being evaluated could require between one and three large storm events to flush impounded sediments from the reservoir. The *Hydrologic Assessment for Water Supply* (URS and Stillwater Sciences 2014) memorandum concludes that restricting diversions during a typical "wet cycle" period would have little to no effect on water levels in Lake Casitas. However, implementation of the dam removal project during a typical "dry cycle" would result in a loss of water volume of approximately 5% (12,700 AF) of the total reservoir volume, per storm event.

For this analysis, it is assumed that only one high-flow storm event occurs in a single year during a dry cycle period. Multiple high-flow storm events in a single year would be indicative of a wet cycle, where restricting diversions would have minimal impact on water levels in the reservoir. As such, the recommendations presented below evaluate the potential mitigation water volumes against the loss of water during a dry cycle period.

Of the 23 Mitigation Options presented, 9 are being recommended for further analysis and are summarized in Table 6-1 below. While any of these alternatives can be executed in isolation, in order to mitigate the full range of possible impacts, it is recommended that each be examined further.

Table 6-1. Recommended Mitigation Alternatives

Type of Mitigation	Description	Volume[1.] (AFY)	Volume[2.] (% per year)	Cost ($)
Replacement Supplies	CMWD Transfers to MOWD	N/A	N/A	$20K
	New Wells at Santa Paula Basin	1,400	11%	$250K
	New Well Head at Foster Park	750	5.9%	$1.5M
Re-Use & Conserve	Urban and Agricultural Conservation	250	2.0%	$191K
	Crop Idling Transfers	800	6.3%	$5.95M
Treatment	Casitas Reservoir Oxygenation Enhancement	N/A	N/A	$5K
	Back-flushing of Meiners Oaks Wells 1 and 2	83	0.7%	$20K
	CMWD Water Treatment Plant System Modifications	Varies[3.]	Varies[3.]	$250K + $10K/year

1. Potential additional or saved volume of water.
2. Potential percentage of loss water volume mitigated.
3. Amount of volume mitigated depends on level of additional treatment implemented.

Impacts to Meiners Oaks Water District from the potential loss of Wells 1 and 2 along the Ventura River could be mitigated by importing additional water from CMWD at surcharged rates, as well as by providing a one- time well flushing of each well, following the peak flushing of Phase I.

Additional supply to the City of Ventura from new wells in the Santa Paula Basin and completion of the wells at Foster Park would increase overall water supply flexibility to all of CMWD's customers as well as the City.

Conservation and crop idling would increase the overall flexibility of water supply and benefit all water users, while being relatively low impact in terms of cost and the environment. While the quantity obtainable from fallowing would vary depending on the agreements that could be reached with local landowners, these alternatives are likely to be feasible.

Finally, some water quality impacts are likely at Casitas Reservoir and Meiners Oaks where treatment alternatives could best address organics and fines in the water supply. These alternatives will improve the ability to take water, and the ability to delivery water that meets delivery standards. However, additional information from explorations of the existing reservoir sediment would help to quantify the risk.

Before implementation of any mitigation measures, input should be sought from regional stakeholders, and further research should be performed on legal, environmental and other considerations that may affect the ability to implement them. In addition, detailed design and cost estimating will be required to determine the quantity of water that could be recovered from each, and the total return on investment.

7.0 Limitations

The services presented herein were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession in developing the dam removal mitigation concepts and their associated construction costs, given the amount of existing site and design information available at the time of preparation of this report. No other warranties, expressed or implied, are included or intended in this document.

No field work was conducted for this study. This report is conceptual or preliminary in nature and is not to be used as the sole basis for final design or construction, or as a basis for major capital decisions. Further preliminary detailed design should be performed prior to such decisions.

Some background information, design bases, and other data have been furnished to AECOM by the U.S. BOR, CMWD, Ventura County and/or third parties, which AECOM has used in preparing this report. AECOM has relied on this information as furnished, and is neither responsible for nor has confirmed the accuracy of this information.

8.0 References

AECOM & Stillwater Sciences. (2015). *Draft Dam Removal Concepts Evaluation Report.*

Bren School of Environmental Science & Management. (2013). *Sustainable Water Use in the Ventura River Watershed.*

CA Department of Water Resources. (2014, February 27). *A Guide to Water Transfers*. Retrieved March 11, 2015, from http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/4-1.pdf

Daniel B. Stephens & Associates, Inc. (2009). *Assessment of Potential Impacts to MOWD Wells.*

MOWD. (2014). *Drought Contigency Plan.*

RBF Consulting. (2013). *Ventura Water 2013 Comprehensive Water Resources Report.*

Stillwater Sciences A. (2014). *Matilija Dam Removal Coarse Sediment Transport Model Setup & Preliminary Results.*

Stillwater Sciences C. (2014). *Matilija Dam Removal, Sediment Transport, & Robles Diversion Mitigation Study. Watershed and Impoundment-Area Sediment Characterization, Task 2.2.*

Stoecker Ecological. (2007). *Ojai Valley Sanitary District Effluent Reuse Feasbility Analysis.*

URS & Stillwater Sciences. (2014). *Matilija Dam Removal, Sediment Transport, & Robles Diversion Mitigation Project. Hydrologic Assessment for Water Supply.*

Ventura County. (2014). *Crop & Livestock Report 2013.*

Water Quality Solutions. (2013). *Feasibility Study of a Hypolimnetic Oxygenation System for Lake Casitas.*

Wickstrum, S., & Merckling, R. (2011). *CMWD 2010 Urban Water Management Plan.*