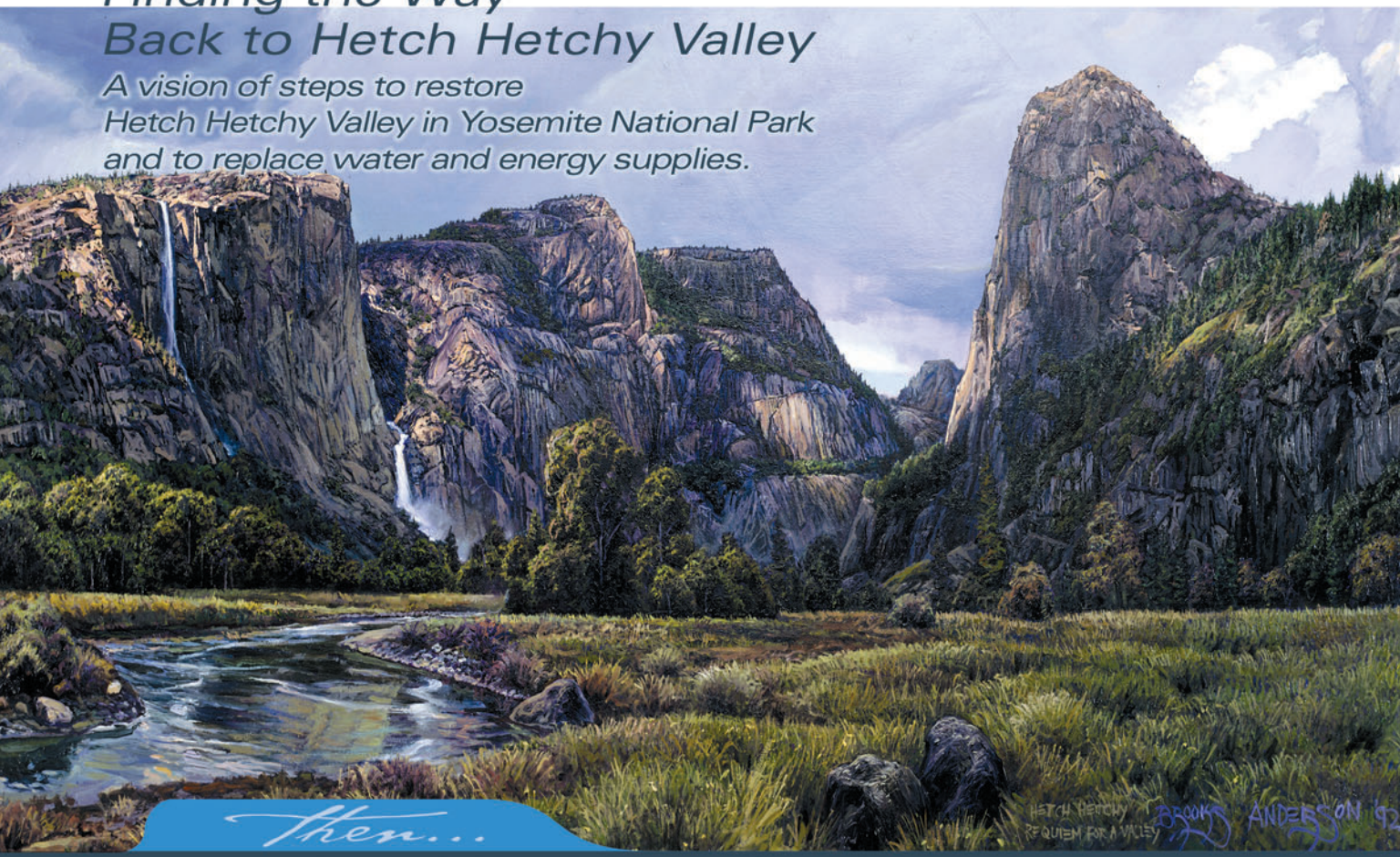
Restore Hetch Hetchy

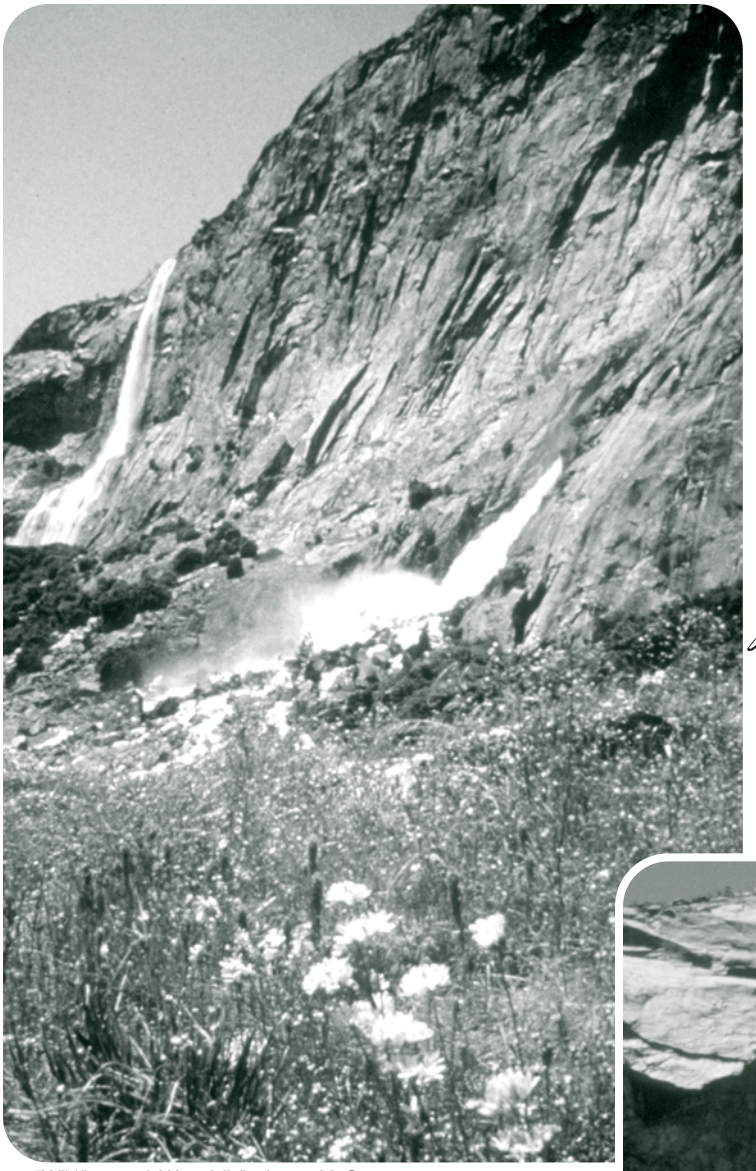
IN YOSEMITE NATIONAL PARK

Finding the Way Back to Hetch Hetchy Valley

A vision of steps to restore Hetch Hetchy Valley in Yosemite National Park and to replace water and energy supplies.



FEASIBILITY STUDY 2005



"Wildflowers & Waterfalls" - James McGrew

"Imagine yourself in Hetch Hetchy... ...on a sunny day in June, standing waist-deep in grass and flowers (as I have often stood), while the great pines sway dreamily with scarcely perceptible motion . . .

Tueeulala Fall is the most graceful waterfall I have ever seen. . . Wapama Fall (descends) roaring and thundering, pounding its way like an earthquake avalanche."

– John Muir, The Yosemite

"Tueeulala Fall" by Ron Good

"Dam Hetch Hetchy! As well dam for water-tanks the people's cathedrals and churches, for no holier temple has ever been consecrated by the heart of man."

– John Muir, The Yosemite

"Hetch Hetchy Valley . . . is a grand landscape garden, one of Nature's rarest and most precious mountain temples."

– John Muir, The Yosemite

"Hetch Hetchy: Requiem for a Valley" by Brooks Anderson

PREFACE

Yosemite's beautiful Hetch Hetchy Valley, flooded by O'Shaughnessy Dam in the early part of the twentieth century, must be restored. The American people deserve nothing less. This magnificent valley, the virtual twin of Yosemite, was drowned because Congress passed the Raker Act in 1913, allowing San Francisco to use one of the treasures of the young National Park system as a reservoir.

"John Muir" by Francis Fultz
Courtesy of National Park Service

John Muir said: "What people have destroyed, people and nature can restore". We all can bring the aesthetic, economic, wildlife, and recreational values of the valley back to life by replacing the water and power provided by the dam, draining the reservoir, removing the dam, and helping the landscape heal itself.

The dam was built to supply San Francisco and its neighbors with water and power. These are real needs that cannot be ignored. Meeting them is an integral part of the solution to the Hetch Hetchy problem. Not only must the water and power supplies for San Francisco and its Bay Area customers be preserved, but they should be made even more reliable and less damaging to the environment. The solution must also be crafted so that the economic, flood control, water, and power requirements of Tuolumne and Stanislaus Counties, including the Turlock and Modesto Irrigation Districts, are met.

Pre-Dam photo of Hetch Hetchy from Sierra Club Bulletin early 1900s

There is a way to do all this, both practically and economically. This report explains how. It lays out a series of options for replacing the water supply, flood control, and hydropower benefits that the dam provided, removing the dam, and restoring the valley. Thoughtful studies by other organizations have laid a solid foundation for many of these steps. This report builds on their work, and brings to light new cost-effective options for water and power supplies. It will take determined elected officials, supported by an engaged public, to turn these ideas into reality. The reward will be a second Yosemite — a splendid legacy for generations to come.

* * *

This report was prepared by volunteer engineers, biologists, historians, and other supporters of RESTORE HETCH HETCHY, a nonprofit organization dedicated to removing the dam and restoring the valley. For more information about how the report was prepared, to obtain additional copies of this report, and to learn how you can help with this effort, please see page 85.

Former Secretary of Interior Don Hodel has said that if we can restore the Statue of Liberty, our nation's symbol of freedom, we can restore Hetch Hetchy, one of our greatest natural treasures. RESTORE HETCH HETCHY couldn't agree more.

Thank you for taking the time to read this plan and becoming involved in its implementation.

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Library of Congress Control Number 2005902659
PRINCIPAL AUTHOR: GERALD H. MERAL, PH.D.

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RESTORING HETCH HETCHY VALLEY:
The cause that never died

The movement to conserve the environment has been able to celebrate glorious victories. But many people have never forgotten its first defeat: the damming of Hetch Hetchy Valley in Yosemite National Park. John Muir called this splendid landscape the "second Yosemite." Its loss broke his heart — and proved that national parks were not sacrosanct.

One reason Americans feel that nature reserves, including national parks, are important is that they are areas set apart from commerce. They are supposed to be closed to economic exploitation. But that principle had not yet been established in 1913, when Congress passed the Raker Act allowing the City of San Francisco to build a dam and reservoir on the Tuolumne River in Hetch Hetchy Valley. In a battle between competing public uses — public water and power versus inviolate parks for the people — water and power won.

Conservationists never forgot about Hetch Hetchy, but the subject rarely caught the public's eye — until 1987, when Donald Hodel, Secretary of the Interior under President Ronald Reagan, proposed taking down O'Shaughnessy Dam and restoring Hetch Hetchy Valley.

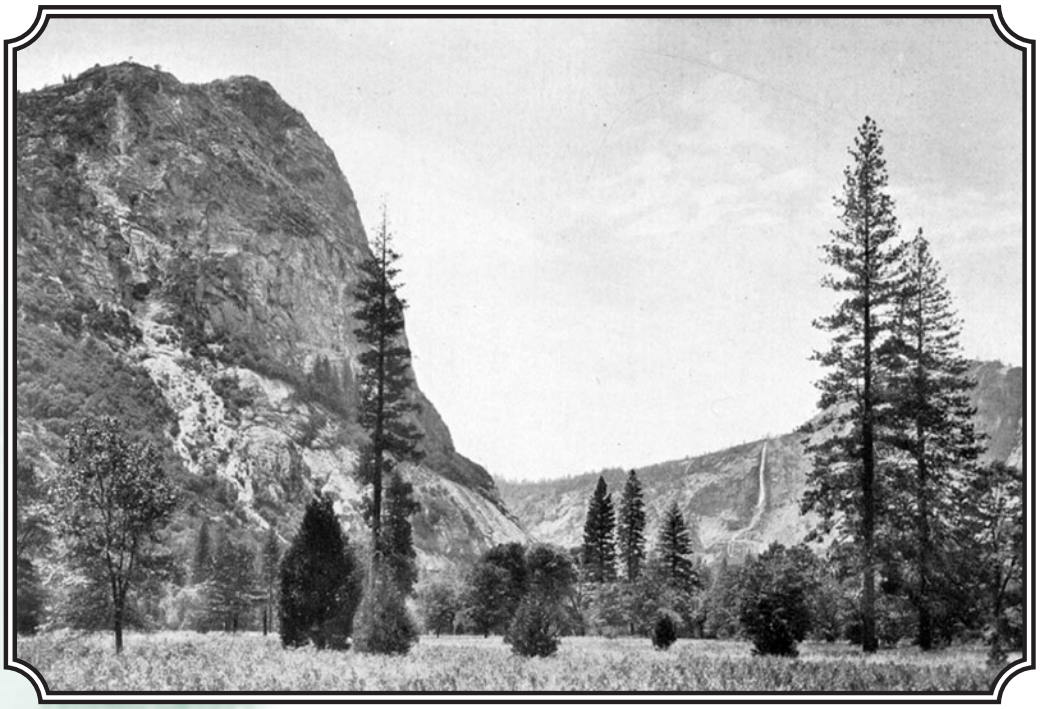
I had known Hodel since college days, when he and I championed opposing political causes. Later, as Interior Secretary, he took positions that made him seem anything but a conservationist. Given his background, his proposal to restore Hetch Hetchy seemed out of character. But Hodel directed the Bureau of Reclamation to study how the dam might be removed and the water and power replaced. Suddenly, the idea was transformed from a lost cause of the past into a practical hope for the future.

In a published article at the time, Interior Secretary Hodel said, "Restoration of Hetch Hetchy Valley to its natural state may be a dream, but it is our obligation as concerned Americans to discover if this dream can become a reality. It is for our generation to decide that this is an investment for future generations. . . . If we succeed, America can once again boast its position as a world leader in the care, improvement, and restoration of our National Parks."

In 1999 Restore Hetch Hetchy was formed as a grassroots organization especially devoted to the idea that O'Shaughnessy Dam could be taken down, Yosemite National Park's Hetch Hetchy Valley could be restored, and the needs of the San Francisco Bay Area's water and power users could be accommodated in other ways.

Americans are now realizing that natural streams are too scarce because we went overboard in damming too many rivers in the past. Older dams are now gradually being removed. The era of restoration has arrived.

What better place is there to restore a natural landscape and an undammed mountain river than in Hetch Hetchy Valley? John Muir called it "a grand landscape garden, one of Nature's rarest and most precious mountain temples." Never in our nation's history has such an extraordinary site been lost in a place that was supposed to be protected by the United States government. Our country has exported the national park idea to the world, and we urge everyone to uphold the sanctity of land consecrated in this fashion to nature. And yet, nearly a century ago, we failed to do so ourselves when we let Hetch Hetchy Valley be flooded.



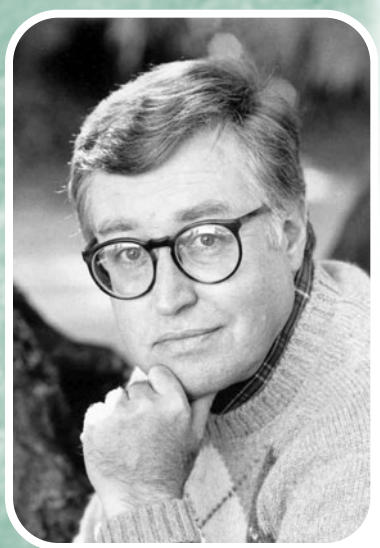
"Grand Landscape Garden" by Herbert Gleason, Sierra Club Bulletin

It is time to correct this tragic mistake. For more than nine decades, paying rent of only $30,000 per year, the City of San Francisco has enjoyed the right to use Hetch Hetchy Valley as a water tank. Surely that is long enough. It is time for the American people to reclaim the "second Yosemite" that it lost at Hetch Hetchy and for nature to begin the process of healing.

In our lifetimes, we have seen other major structures torn down, from the Berlin Wall to San Francisco's Embarcadero Freeway. So also can the dam and reservoir in Hetch Hetchy Valley be removed. In our lifetimes, we have seen the City of Los Angeles make accommodations to restore Mono Lake. So also can the City of San Francisco make accommodations to restore Hetch Hetchy Valley.

How Hetch Hetchy can be restored in the most beneficial way is the subject of this study. Experts have been assembled to grapple with all the engineering practicalities and to analyze all the alternative water and power sources. This study marshals the facts and figures that demonstrate that our hopes are not misplaced and that our dreams are not fantasies. Restoring Hetch Hetchy Valley does make practical sense. There can be a "win-win" outcome. This report points the way.

It is time for the healing process at Hetch Hetchy Valley to begin.

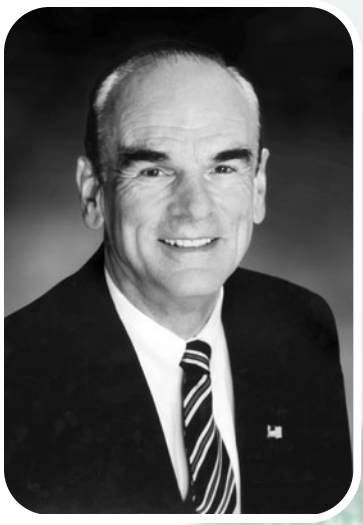


Michael McCloskey
Sierra Club, Executive Director (1969–1985)
Sierra Club, Chairman (1985–1999)
Restore Hetch Hetchy Advisory Committee (1999–present)

RESTORING HETCH HETCHY: A PRACTICAL IDEA WHOSE TIME HAS COME

A letter from former Secretary of the Interior Donald Hodel

As Secretary of Interior under President Reagan, I was concerned that the Hetch Hetchy Valley, which would have been a premier visitor destination in Yosemite National Park, was managed for a single purpose for the sole benefit of one region of California.



That is not to say that the water and power needs of the Bay Area and the Central Valley are not real. Indeed, they must be fulfilled for the benefit of the people living there.

I proposed a study to determine if it might be feasible to remove Hetch Hetchy Reservoir and restore Hetch Hetchy Valley as a vital part of one of our greatest national parks. I recognize that when Congress passed the Raker Act in 1913, it may have appeared that the best way to meet water and power needs for San Francisco was to flood what is now part of Yosemite National Park. But a wide variety of techniques now exist that can meet those needs, including, but by no means limited to, expanded water storage facilities, water efficiency, wastewater reclamation, and groundwater management.

The power needs of California must also be met when the dam is removed. Combined cycle turbines, solar energy, energy efficiency, reconfiguring the existing power system and a host of other options on or off the Tuolumne River can make California power users whole.

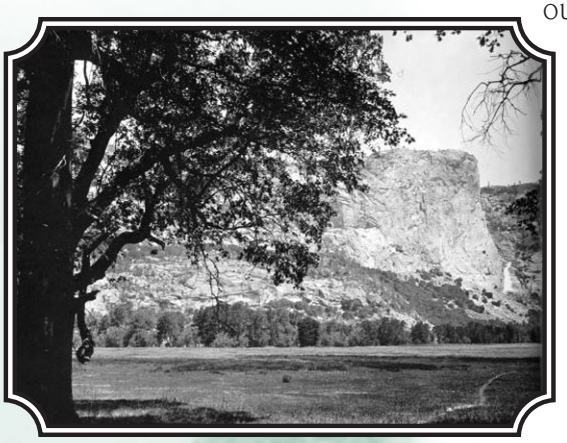
I worked hard to restore and preserve our great system of national parks. Scholars have called the national parks "America's greatest idea," and that idea has spread throughout the world. Now we can take the next step. If we can find a way to remove the reservoir, we can resurrect one of the most important features of a national park that attracts millions of visitors a year. This new feature will buoy the local economy of the Central Sierra Nevada, and make Yosemite an even more attractive place to visit.

Partisan differences will always occur in decisions over the use of our natural resources. But we all can agree that restoring Hetch Hetchy should be a non-partisan cause embraced by all those seeking a useful, productive, and great national park system.

Donald Hodel
Secretary of the Interior, 1985-1989

EXECUTIVE SUMMARY

When Congress approved the construction of O'Shaughnessy Dam in Yosemite National Park's Hetch Hetchy Valley in 1913, it concluded a decade long battle over the future of a rare glacial valley in one of our greatest national parks. Those seeking to make maximum economic use of Hetch Hetchy won out, and the dam on the Tuolumne River has reliably supplied water and power to the Central Valley and the Bay Area for 70 years.



Pre-Dam photo of Hetch Hetchy's El Capitan - J.N. LeConte/Sierra Club

In 1913 few people had ever seen Yosemite Valley, and far fewer had visited Hetch Hetchy. The question of devoting a large part of a national park to commercial uses was largely theoretical. Today Hetch Hetchy would be visited by millions, and the value of bringing the valley back would be enormous.

Restoring Hetch Hetchy Valley would provide substantial economic and environmental benefits. The water and power currently supplied by the dam can be replaced from other, more reliable sources, improving the economic stability of the service areas.

Water from Hetch Hetchy Reservoir can be replaced by a combination of measures. Pumping from Cherry Creek (a Tuolumne River tributary) into the Mountain Tunnel will replace much of the water formerly stored in Hetch Hetchy. Other good options include extensive water efficiency improvements and wastewater recycling in the Bay Area, using water from Don Pedro Reservoir downstream on the Tuolumne, greater use of groundwater in the watershed during droughts, and increasing the capacity of existing reservoirs.

Draining Hetch Hetchy Reservoir would reduce power generation. But much water could still be captured below the dam site and diverted into the existing power tunnels and powerhouses, which would continue to produce electricity. The diversion from Cherry Creek described above could also replace much of the lost power.

"Hetch Hetchy: Requiem for a Valley" by Brooks Anderson

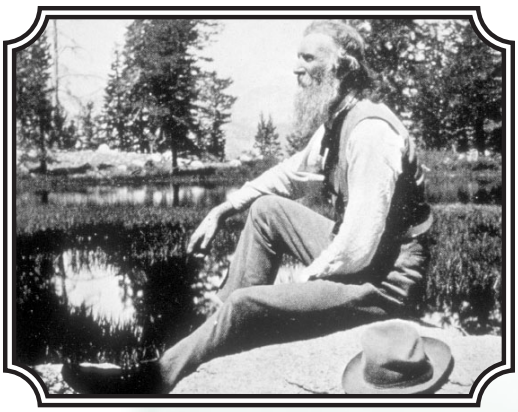
The remaining power could be replaced from a wide variety of sources, including energy efficiency, solar photovoltaic cells, and more conventional sources such as a combined cycle power plant. Energy conservation alone would save Bay Area energy consumers more money than implementing the program would cost.

The new water and power supply program must be in place before the reservoir is drained. The entire program can be paid for by a combination of state general obligation bonds, federal funds, and private donations. The extent to which the water and power users should help pay for the restoration of the valley must be determined, but they will benefit financially from the alternative water and power solutions that are implemented.

Removing the reservoir would result in an immediate ecological rebirth of Hetch Hetchy Valley, with substantial revegetation — some by human intervention and some by natural processes — and repopulation by wildlife taking place in less than ten years. Several hundred thousand people a year could be expected to visit the restored Hetch Hetchy Valley, compared to the 50,000

annual visitors to the dam now. This would provide a huge economic benefit to Mariposa and Tuolumne Counties of as much as $60 million per year.

San Francisco built a water and power system that served it well during the twentieth century. Those who planned and built this system are rightfully proud of their accomplishment. Now, in the twenty-first century, we have an opportunity to return Hetch Hetchy Valley to a natural state and make it a much more significant part of Yosemite National Park — and, at the same time, give San Francisco and its customers and the Modesto and Turlock Irrigation Districts an improved and more reliable utility infrastructure.



"John Muir at a Sierra lake" Sierra Club Bulletin

RESTORING HETCH HETCHY AND SUPPLYING WATER AND POWER

WATER AND POWER

Hetch Hetchy Reservoir holds less than one percent of all the water behind dams in California. The state has 19 reservoirs larger than Hetch Hetchy.

The reservoir supplies less than twenty percent of the water used in the nine Bay Area counties, only three percent of the water used in the cities of California, and less than one percent of all the water used in California each year.

The water supplied by Hetch Hetchy in most years can be replaced with water from the Tuolumne River and its tributaries by implementing a few relatively inexpensive projects.

- Continue to divert water from the Tuolumne River into the San Francisco water system after the dam is removed. This can be done just downstream from Hetch Hetchy Valley with a simple diversion structure. This will preserve much of the power the reservoir currently generates. (Figure 1B)

- Pump water from Cherry Creek into the San Francisco water system. In most years this replaces the water that is not captured just downstream from Hetch Hetchy Valley, and provides additional power. (Figure 1A)

- Enlarge existing Don Pedro Reservoir downstream on the Tuolumne River, or enlarge Calaveras Reservoir in the Bay Area, or better utilize underground water supplies to fully make up the Hetch Hetchy Reservoir supply in dry years.

- Implement comprehensive water efficiency and water recycling programs to reduce consumer bills and stretch existing water supplies.

- Improve treatment of the water by installing new filtration equipment for water from the Tuolumne River.

Removal of the dam would result in the loss of less than two-tenths of one percent of California's yearly electricity use.

All the lost power could be replaced by the new water programs described above, plus an energy efficiency program. The efficiency program would actually save homeowners and businesses more than the cost of implementing the energy efficiency program. It would also be possible to build solar, wind, or conventional gas-fired power plants.

COSTS

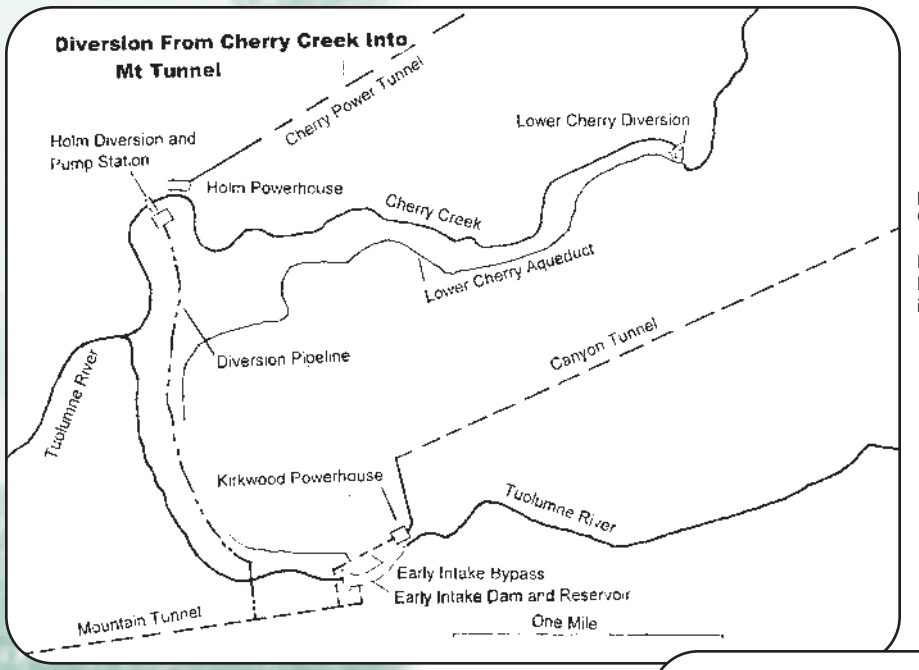
Costs include replacing water and power supplied by Hetch Hetchy Reservoir, removing the dam, restoring the valley, and adding water filtration. Total cost would be less than one billion dollars. This cost would quickly be made up by consumer energy savings resulting from energy efficiency programs, and by economic growth due to the expansion of tourism in Yosemite National Park.

JOBS

Dam removal would take five years, and create 490 construction jobs and 4,210 total jobs, including secondary employment. Hundreds of new permanent jobs would be created serving the many visitors who would come to see the restored Hetch Hetchy Valley.

SOCIAL JUSTICE

Implementing the water and energy conservation programs primarily in low-income communities would greatly benefit residents of those communities.



Diversions to Save Energy and Water
Credit: Bob Hackamack

Figure 1A
Diversion from Cherry Creek into Mt. Tunnel

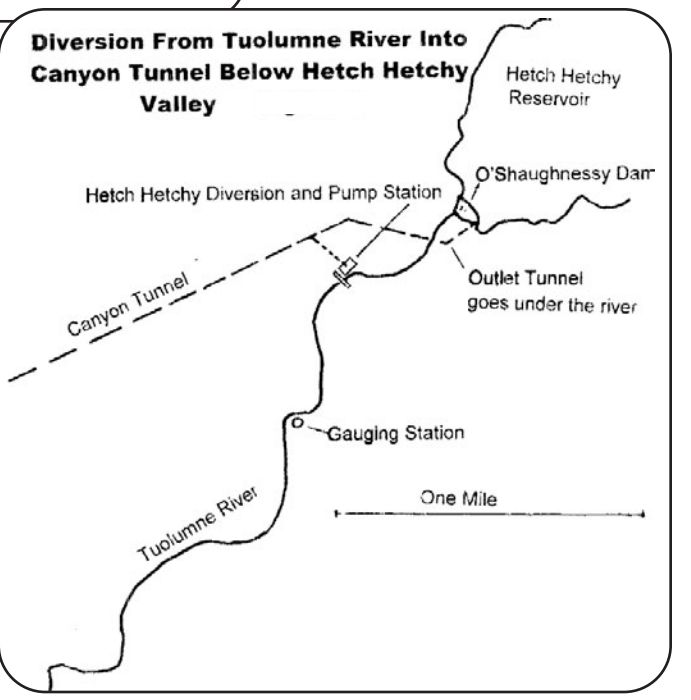


Figure 1B
Diversion from Tuolumne River Into Canyon Tunnel below Hetch Hetchy Valley

NATURAL HISTORY

"A grand landscape garden, one of Nature's rarest and most precious mountain temples"

John Muir

John Muir drawing of Hetch Hetchy Valley
Credit: University of the Pacific

GEOLOGY

Hetch Hetchy's granitic landscape began to take shape more than 100 million years ago when molten material intruded deep within the earth's crust. This material solidified, and overlying rocks eroded away, exposing the granite — which was, in some areas, "shaped into bold forms" such as the "cliffs of Yosemite and Hetch Hetchy Valleys." [i]

Some 25 million years ago, the Sierra Nevada began to form as flat lowland areas were lifted up and tilted toward the southwest. As the rate and degree of tilt increased, streams flowing toward the Central Valley cut deep canyons into the mountain block.

Three million years ago, glaciers formed among the high mountains. "The icefield in the upper Tuolumne River basin, and in the tributary basins to the north, fed the glacier that moved down the canyon of the Tuolumne River through Hetch Hetchy Valley."[ii] Uplift continues today.

HYDROLOGY

The entire northern part of Yosemite National Park — an area of 669 square miles — is drained by the Tuolumne River. The river is formed high in the mountains at the confluence of the Dana Fork, which drains the west-facing slopes of Mount Dana, and the Lyell Fork, which rises at the base of the glacier on Mount Lyell. These streams join in Tuolumne Meadows, then flow through the Grand Canyon of the Tuolumne, into Hetch Hetchy Reservoir. [iii]

BIOLOGY

Before it was dammed, Hetch Hetchy Valley was "open meadows and black oak woodlands stretched along the entire six mile length and from wall to wall. . . . Deer were abundant, feeding on acorns and shrubs. . . The oak woodlands attracted black bears and provided a staple food for the Indians who hunted the deer. Mountain lions also hunted the deer by hiding in the oaks and occasional conifer woodlands. Sometimes grizzly bears would wander into the valley from the Sierra foothills . . . . There were also predators in the air . . . . Golden eagles nested along the valley rim, and peregrine falcons engaged in aerial attacks above the meadows . . . But there were more wonders in this valley. . . a plethora of habitats including dry foothill woodland, wet and dry meadows, ephemeral lakes, marshes, black oak and conifer woodlands, springs, seeps, rocky outcrops, grassy benches, cliff crevices, and high montane forests. . . almost 700 species of plants inhabited this five square mile valley, by far one of the richest assemblages of plants in California."[iv]

HUMAN HISTORY

Native Americans in Yosemite Valley
Courtesy of National Park Service

Unlike the narrow, V-shaped canyons cut into downstream mountains and foothills by Sierra rivers, the wide, U-shaped valleys of Yosemite and Hetch Hetchy were carved by glaciers and feature walls that drop nearly vertically to the broad valley floors. The glaciers removed rocks and debris, making these areas even more suitable for human occupation. [v]

The Miwoks, a prominent tribe of native Californians, started entering the Sierra from the Central Valley at least 2,000 years ago, presumably to escape the Central Valley spring floods and summer heat.[vi] The Central Sierra Miwoks were the primary inhabitants of the upper reaches of the Tuolumne River drainage,[vii] including Hetch Hetchy Valley.

Native Americans in Yosemite Valley
Courtesy of National Park Service

Because resources in the valley were plentiful, experts think it is likely that the Indians occupied Hetch Hetchy year-round.[viii] Linda W. Greene describes Yosemite before European contact as "an area of isolation, beauty and abundance of game, fish, plant foods and water — an ideal haven for early peoples. The Miwok hunted grizzly and black bears, deer, and elk, and smaller mammals such as rabbits and grey squirrels. They also utilized several bird species and trout...the native population gathered clover and bulbs in the spring; seeds and fruits in the summer; acorns, nuts, and manzanita berries in the fall; and mushrooms in the late winter and early spring. Black oak acorns, the preferred starch of the California Indian's diet, occurred in the Yosemite region in abundance."[ix] The Miwok word "hetchetci" described seeds from "a grass growing in Hetch Hetchy valley and from which a mush was made."[x]

Other tribes, mainly the Mono Paiutes and the Washoes, regularly visited and occasionally occupied the Central Sierra.[xi] According to L. Kyle Napton, "The juxtaposition of these three tribes in the Yosemite area occurs nowhere else in California." [xii]

The Miwoks traded baskets, beads, arrows, and manzanita berries to the Paiutes for baskets, obsidian, projectile points, salt, rabbit skin blankets, pinyon nuts, pigments, buffalo robes, and fly pupae. The Washoes received acorns, shell disks, soaproot fibers, redbud bark, and manzanita berries in exchange for pinyon nuts, rabbit skin blankets, dried fish and buffalo skins. [xiii]

"Buffalo Soldiers"
Courtesy of National Park Service

Early Europeans apparently used Hetch Hetchy Valley to pasture sheep, although there is little historical documentation. The first Europeans in the valley were the brothers Joseph and Nathan Screech, who arrived in 1850.

Yosemite National Park was created on October 1, 1890, a result of John Muir's fight to save the subalpine meadows surrounding Yosemite Valley. The park included Hetch Hetchy Valley. Military units, including a unit of African-American "Buffalo Soldiers" (some of whom were stationed at Hetch Hetchy), were assigned the task of administering the park. In 1916, Congress authorized the creation of the National Park Service.[xiv]

THE BATTLE FOR HETCH HETCHY

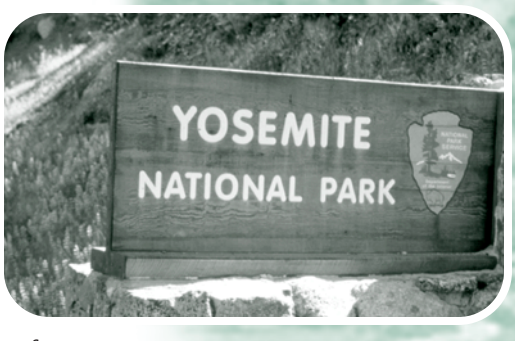
Nearly every city in the southwestern United States has reached beyond its watershed for water. The dry climate requires water supplies from the mountains, and so Los Angeles, San Diego, Tucson, Salt Lake City, Denver, Phoenix, and Oakland have all undertaken inter-basin water transfers to slake a growing thirst.


Gifford Pinchot

San Francisco was no different. From the mid-1800s to the early 1900s, boosters of San Francisco as an "Imperial City of the West" took every opportunity to extract natural resources — timber, gold, lead, silver, and water — from the rural areas of California and beyond. Chief among the boosters was James D. Phelan, Mayor of San Francisco. Phelan and other San Francisco officials cast their eyes on the Tuolumne River in Hetch Hetchy Valley as the main source for their future public water supply. No other place would do, the boosters claimed, despite the protestations of John Muir, the nation's leading conservationist and outspoken advocate of preserving Hetch Hetchy Valley. Muir had carefully documented numerous other water sources for San Francisco outside Yosemite National Park.

In Hetch Hetchy's defense, Muir exclaimed, "These temple destroyers, devotees of ravaging commercialism, seem to have a perfect contempt for Nature, and, instead of lifting their eyes to the God of the mountains, lift them to the Almighty Dollar."[xv]

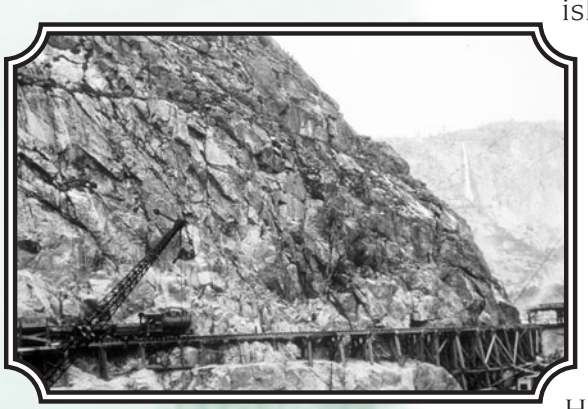
Despite the fact that Hetch Hetchy Valley was part of Yosemite National Park, there were those who saw all public lands as available to serve any public need. These utilitarians were led by Gifford Pinchot, the Chief of the U.S. Forestry Department. John Muir and the "nature lovers," the Turlock Irrigation District, the Modesto Irrigation District, one of California's United States Senators (John Works), and nearly every major newspaper in the country were aligned on the other side.



On September 4, 1913, the New York Times editorialized, "The only time to set aside national parks is before the bustling needs of civilization have crept upon them. Legal walls must be built about them for defense, for every park will be attacked. Men and municipalities who wish something for nothing will encroach upon them if permitted. The Hetch Hetchy Valley in the Yosemite National Park is an illustration of this universal struggle. . .

"The politicians of San Francisco care nothing for matters of natural beauty and taste. They have an eye only for utility, a utility

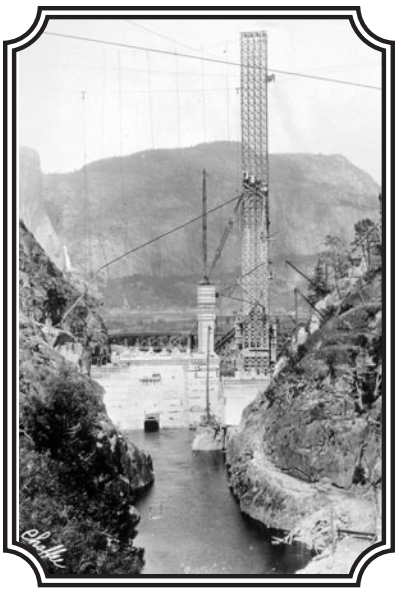
"Field of Stumps in Hetch Hetchy" by Philip Hyde, 1955



O'Shaughnessy Dam under construction, Sierra Club Bulletin

that flows their way. The chief newspapers and organs of public opinion throughout the country have spoken in opposition to the 'grab.' We trust that the Senate will heed their expression of public sentiment, and, failing that, that President Wilson will veto the measure." But Wilson failed to do so.[xvi]

A few years later, San Francisco cut down all the trees on the Hetch Hetchy Valley floor and proceeded to build O'Shaughnessy Dam, which was completed in 1923. Hetch Hetchy Valley had become the "water tank" that John Muir railed against. It took years to finish the construction of facilities to pipe the water from Yosemite through the mountains and foothills, across the Central Valley, through the Coast Range, across San Francisco Bay, and into San Francisco, where the water finally arrived in 1934 (Figure-inside back cover). Later, the Holm and Kirkwood Powerhouses were constructed downstream on the Tuolumne and its tributaries, outside the boundaries of Yosemite National Park, and added to San Francisco's water and power system.



"O'Shaughnessy Dam under Construction" City of San Francisco

The fight over Hetch Hetchy was the first highly visible nationwide conservation battle. It galvanized those who were disturbed over the rampant destruction of the environment by logging, mining, market-oriented wildlife hunting, and uncontrolled development. There is little doubt that Congressional passage of the National Parks Organic Act in 1916, three years after the Raker Act, was stimulated by Congressional concern that San Francisco's dam in Yosemite National Park would be envied and emulated by others who sought to use national park resources for their own advantage. By enacting the Organic Act, Congress essentially said, "Never Again!" to future would-be exploiters of our national parks.

Since the loss of Hetch Hetchy, "Never Again!" has been the battle cry against those who would invade the national parks for purely commercial purposes.

Hetch Hetchy Valley Dam builder - O'Shaughnessy

HETCH HETCHY VALLEY AND O'SHAUGHNESSY DAM TODAY

Current visitor use of Hetch Hetchy Valley and Reservoir

According to a survey by Yosemite Area Regional Transportation Strategy[xvii], Hetch Hetchy is the least visited part of Yosemite National Park. More people hike into the Yosemite backcountry than drive to Hetch Hetchy. While Yosemite Valley attracts 3.4 million visitors annually[xviii], only 50,000 travel to Hetch Hetchy.

The only permitted uses of Hetch Hetchy Valley are fishing from the shore and hiking and backpacking along trails high above the reservoir. No boats are allowed on the reservoir, even though boating and fishing access is allowed on other reservoirs in the area that supply drinking water, such as Cherry Valley, Pardee, and Don Pedro Reservoirs. After the terrorist attacks of September 11, security has been increased, day-use hours are limited, and overnight parking at the reservoir site is prohibited.

In contrast to the restricted use of Hetch Hetchy Valley, public use is encouraged and growing along the Tuolumne River downstream, both within the boundaries of the Stanislaus National Forest and on Bureau of Land Management lands. Whitewater rafting and kayaking are popular from Holm Powerhouse on Cherry Creek to the confluence of Cherry Creek and the Tuolumne and downstream all the way to Don Pedro Reservoir. More than 7,000 people boat this section of the river every year, despite the difficult Class IV and V rapids[xix]. Many thousands more camp at Lumsden Campground and fish the Tuolumne for trout.

After a 15-year battle over two proposed hydroelectric dams on the Tuolumne, Congress designated the Tuolumne River from its headwaters in Yosemite National Park to Don Pedro Reservoir as a component of the National Wild and Scenic Rivers System. The only portion left out was the reservoir in Hetch Hetchy Valley and the area around Kirkwood Powerhouse. When the reservoir is removed, this missing link in Hetch Hetchy Valley should also be designated as part of the Wild and Scenic Tuolumne River.

CLAVEY RIVER

The Clavey River is a large tributary of the Tuolumne. It too was the focus of proposed hydroelectric development, including dams and tunnels. The Tuolumne River Trust, a nonprofit conservation organization, successfully opposed this inappropriate development, and the project's proponent built a combined cycle gas turbine power plant instead. The Trust continues to seek to have the Clavey designated a National Wild and Scenic River. The river was included in proposed legislation by California Senator Barbara Boxer in 2004.

O'Shaughnessy Dam and Reservoir photos - Ron Good

RELATIONSHIP TO OTHER CALIFORNIA WATER AND POWER SUPPLIES

The construction of O'Shaughnessy Dam and the inundation of Hetch Hetchy Valley are so famous — or infamous — that many people overestimate the importance of the reservoir in providing water and power to California and the western states in general.

Hetch Hetchy Reservoir holds only 360,360 acre-feet of water, substantially less than 1 percent of the capacity of all the reservoirs in California. (An acre-foot is 325,900 gallons of water, enough to serve at least two families for a year.)

Compared to more recently constructed reservoirs, this is not a particularly large capacity. Glen Canyon Dam on the Colorado River can hold 24 million acre-feet, and Lake Mead can hold 29 million acre-feet. Some 24 reservoirs in California contain 300,000 acre-feet or more. The state's largest reservoir, Lake Shasta, has a capacity of 4.5 million acre-feet. Don Pedro Reservoir, downstream from Hetch Hetchy on the Tuolumne River has a capacity of over 2 million acre-feet. Together, the 130 California reservoirs that are larger than 40,000 acre-feet contain more than 39 million acre-feet of water. The state has more than 1,000 additional dams with capacities smaller than 40,000 acre-feet[xx].

Of course the size of a reservoir does not directly determine its usefulness. Hetch Hetchy Reservoir serves three purposes: water supply, power generation, and incidental flood control.

As discussed later in this report, there need be no loss of water supply when the reservoir is removed. In fact, with the implementation of the water supply and improved efficiency program in this report, the reliability of the Bay Area's water supply will be substantially improved even without Hetch Hetchy Reservoir.

Presently, Hetch Hetchy Reservoir supplies water to the Canyon Tunnel, which leads first to the Kirkwood Powerhouse and subsequently to the Moccasin Powerhouse downstream. A map of the San Francisco system is shown in Figure 2. By diverting water from Cherry Creek below Holm Powerhouse, and putting it into the Mountain Tunnel, much of the power generation lost in an average year due to removal of Hetch Hetchy Reservoir can be replaced. Power supplies would still have to be augmented by 550 million kilowatt-hours in a median runoff water year.

Electrical energy in California can generally be moved to the site of demand. (Certain restrictions do apply in San Francisco due to powerline capacities.) Total electrical energy use in California in 2001 was 254 billion kilowatt-hours (254,000,000,000 kWh). The loss of power from removal of the reservoir would be less than 0.2 percent of statewide energy use — less than one-fifth of one percent. Although this is a tiny fraction of overall electricity use, it must be replaced. The energy chapter of this report describes how to do so.

FLOOD DAMAGE REDUCTION

Prior to the construction of the enlarged Don Pedro Reservoir in 1971, O'Shaughnessy Dam was an incidental part of a flood damage reduction system on the Tuolumne River. San Francisco's Cherry Valley Reservoir was part of the U.S. Army Corps of Engineers' flood damage reduction system on the Tuolumne prior to the enlargement of Don Pedro Reservoir. Cherry Valley Dam reduced downstream flooding, especially in Modesto and along the lower San Joaquin River.

When Don Pedro Reservoir was enlarged to its present capacity of over two million acre-feet in 1971, the reservation of flood control capacity in Cherry Valley Reservoir was transferred to Don Pedro Reservoir. This meant that the Corps of Engineers no longer required San Francisco to "reserve" space in Cherry Valley Reservoir to capture floodwater. Cherry Valley Dam could be used for water supply and power generation alone.

Don Pedro Reservoir - Ralph Wood

San Francisco argues that Hetch Hetchy Reservoir still serves an incidental flood control purpose, because if there is empty space in the reservoir when a flood comes along, as it did in 1997, the dam might detain some of the floodwater and reduce the amount that would have to be contained by Don Pedro Reservoir downstream. However, even with Hetch Hetchy Reservoir playing this role in 1997, Don Pedro Reservoir overflowed dramatically — for the only time in its history. Indeed, it appears that the actual historical operation of Hetch Hetchy Reservoir provides only about 30,000 acre-feet of flood control space in an average year.

Stanislaus County residents can't reliably count on Hetch Hetchy Reservoir to prevent floods, since San Francisco has the right to keep it completely full, thus removing its capacity to capture floodwater. This means that future flood management on the Tuolumne must rely on two other factors: space reserved in Don Pedro Reservoir for flood control, and restoration of the lower Tuolumne River's floodplain to allow more floodwater to flow harmlessly onto the floodplain. To the extent that the removal of O'Shaughnessy Dam reduces incidental flood protection, it increases the desirability of these additional flood protection measures.

After the removal of O'Shaughnessy Dam, Cherry Reservoir may happen to have space to capture floodwater. But San Francisco would forthrightly reject any call to require that Cherry Reservoir be kept partially drawn down to capture floodwater. For this reason no real, practical flood control benefits can be assigned to Cherry Reservoir.

Revised flood management practices could help solve a variety of problems. RESTORE HETCH HETCHY recommends a change in the Corps of Engineers' storage criteria for Don Pedro Reservoir to require that the reservoir be kept more nearly full in the early fall and late spring. Based on historical flows, there is almost no chance of a flood on the Tuolumne River during these periods. By allowing more water to be stored during the fall and spring, San Francisco would increase its exchange water storage space in the reservoir, the local irrigation districts would have a more reliable supply, and more water would be available for salmon-sustaining releases downstream.

DAM REMOVAL

O'Shaughnessy Dam has played a major role in California history. The dam should be fully documented, and the documents should be placed in the University of California Water Resources Archives and the Bancroft Library before the dam is removed. This project will be carried out in cooperation with the State Office of Historic Preservation.

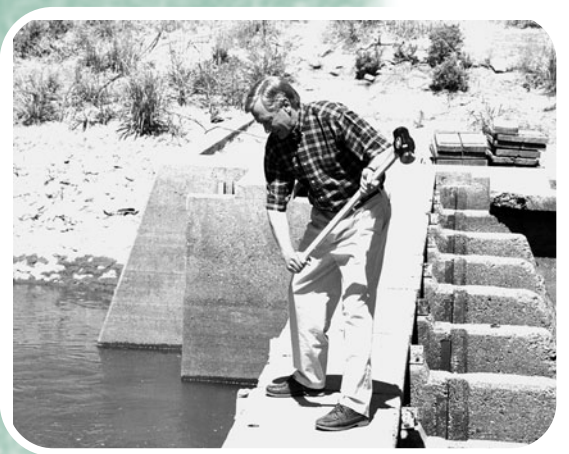
US Senator John Warner R-VA (in hat), Rappahonock River Embrey Dam removal - Friends of Rappahonnock

Dam removal will take five years. The dam's foundation will be left in the bedrock to preserve the hydraulic character of the Tuolumne River's bed at the dam site. If the dam foundation were removed, a vast hole would be left in the river bed.

Many permits will be required before the dam can be removed — permits from the Corps of Engineers, California Department of Fish and Game, Central Valley Regional Water Quality Control Board, and Division of Safety of Dams at the California Department of Water Resources.

US Senator John Warner,
Rappahonock River
Embrey Dam removal ceremony
- Friends of Rappahonnock

The construction of O'Shaughnessy Dam was a major project that disrupted not only Hetch Hetchy Valley, but also much of the surrounding area. Removal of the dam will also be a substantial project that will disrupt Hetch Hetchy Valley and the surrounding area during the five years the project will last. "Best Management Practices" will be used in all environmental protection efforts associated with the razing of the dam, including active revegetation emphasizing native plants, site restoration, the minimization of air and water pollution, sensitivity to Native American cultural sites, the reduction of the impact of any silt that is washed downstream, and the avoidance of toxic contamination.



Former Secretary of the Interior, Bruce Babbitt with sledge hammer.
McPherrin Dam, Butte Creek, California
July 14, 1998
- Mark Volkoff, US Bureau of Reclamation

TRANSPORTATION AND HAUL ROUTES

Approximately 600,000 cubic yards (900,000 tons) of materials — mainly concrete — must be transported from Hetch Hetchy Valley outside the boundaries of Yosemite National Park, probably to a staging facility at the existing quarry on O'Byrnes Ferry Road near the intersection of Highways 108 and 120, west of Sonora. Other uses for the transport routes include movement of construction equipment, fuel and service vehicles, mobile processing facilities, and other miscellaneous materials and supplies.

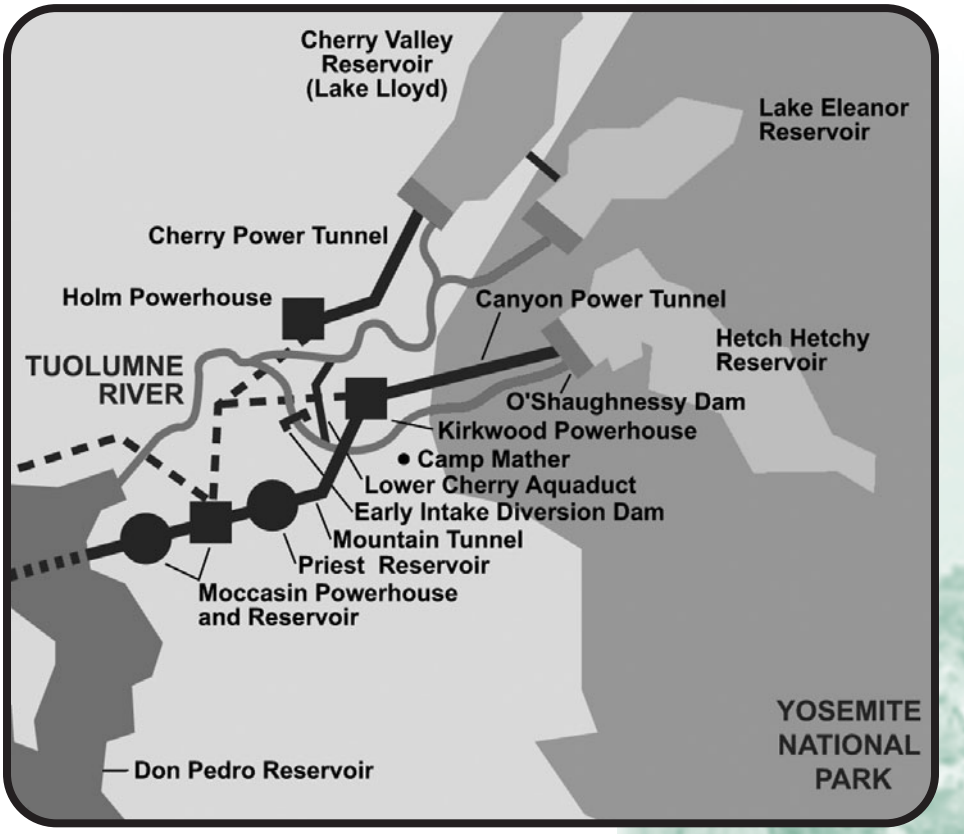
Evergreen Road from Highway 120 to the Hetch Hetchy Road, and all 12 miles of the Hetch Hetchy Road will need to be improved before the deconstruction project can begin.

Concrete debris will be milled at the dam site down to aggregate base rock (a raw material for concrete) and transported by conveyor to the staging area near Camp Mather (Figure 2-inside back cover). Using a conveyor

will allow the contractor to transport concrete debris away from the site at a continuous rate, reducing the improvements required on Hetch Hetchy Road and permitting two-way traffic on the road. Hetch Hetchy Road was a railroad right-of-way during construction of the dam.

At Camp Mather this processed concrete debris will be transferred to trucks for transport to the quarry. To haul the concrete away will require approximately 26,000 transfer loads. The goal of this operation will be to accomplish this off-haul in one season; doing so will require up to 200 truck trips per day.

Camp Mather is close to O'Shaughnessy Dam. This partial SF system map is not to scale.



In the surrounding rural counties, demand for aggregate like that produced by the razing of the dam is very high. According to a 2002 report by the California Geological Survey[xxi], based on expected demand and currently permitted aggregate mines, both Stanislaus and Sacramento Counties have only a ten-year supply of aggregate. The value of aggregate is about $10 per ton[xxii]; selling it will produce about $9 million in revenue for the restoration project.

Transportation of aggregate adds about $0.30 per mile per ton to its value (or cost). Transportation to the Stanislaus County area would at least double the value of the aggregate. RESTORE HETCH HETCHY estimates that the total economic activity associated with the production and re-use of the aggregate will be about $18 million (including transportation costs).

OFF-SITE STAGING AREAS AND EXTENT OF DISTURBANCE

Three major staging areas will be established to facilitate the movement and staging of equipment and materials. Two of the three sites will require numerous environmental protections, mitigation measures, and extensive restoration following construction.

1. The O'Shaughnessy Dam Staging Area will be located at the dam parking area and backpacker camp parking area. This site will utilize existing facilities as much as possible and will require additional temporary facilities to handle construction personnel, traffic, and equipment staging. A concrete crusher, a debris stockpile, and the beginning of the concrete conveyer system will be located here. Construction crews will minimize disturbance of the surrounding area, and unavoidable negative impacts will be mitigated on- and off-site. An alternative backpacker camp will be established near Camp Mather, and a shuttle bus will allow continuing access for hikers and tourists to Hetch Hetchy Valley during the removal of the dam.

2. The Camp Mather Staging Area will be located at an appropriate site near Camp Mather. This site will require road grading, staging location grading, a conveyor to the truck transfer station, a temporary office and other construction personnel facilities, a parking area and shuttle staging, a material and debris staging area, and other miscellaneous facilities. Disturbance at this location will require pre- and post-project mitigation, both on- and off-site, with complete restoration following construction.

3. The Quarry Staging Area will be used to stockpile milled concrete for sale and distribution. It will also act as a starting and ending point for the hauling of material and debris. Additional construction personnel facilities will be located here. It is anticipated that work at this site will have minimal negative impacts on the environment. Mitigation will be required to offset any impacts that do occur.

DECONSTRUCTION PLAN

MOBILIZATION AND ON-SITE STAGING (YEAR 1)

Existing facilities at the backpacker campground and dam parking area are appropriate for expansion and use as part of an on-site staging area for materials and personnel. Existing infrastructure, including power and water, will be linked to a temporary office complex at the backpacker campground. This facility will include several mobile offices, residence for security personnel and visitor facilities. Offices and residences in existence on the east side of the loop road will continue to be used by Hetch Hetchy Water and Power (HHWP) personnel during construction.

The loop road at the dam will be used to route one-way traffic to the offices, to material staging areas at the dam parking lot and at the HHWP residences, and to a traffic holding area for one-way escort on Hetch Hetchy Road. Traffic in this loop will move in the reverse of the current pattern.

The construction contractors will be allowed to stage equipment and materials along the east end of the loop road near the existing restroom facilities. It is anticipated that the concrete milling facilities will be located near the existing spillway, but they could possibly be moved during construction. Temporary residences for construction personnel will not be located within the dam site staging area.

CONVEYOR CONSTRUCTION (YEAR 2)

To minimize truck traffic on narrow, winding Hetch Hetchy Road, a conveyor will be constructed to carry processed concrete debris from the dam site to the staging area near Camp Mather. The material will probably be raised into a hopper for continuous loading to transfers for hauling to the foothills quarry. In addition to being highly efficient, the elevated conveyor will reduce the costs of blasting and grading along Hetch Hetchy Road within the national park.

The conveyer's route will be based on the shortest possible length and minimal disturbance to the surrounding habitat, paralleling the Hetch Hetchy power line as closely as possible to allow easy access for maintenance. Leveling for the conveyer and bolting of its footings will disturb some granite surfaces. Care will be taken to minimize scarring of the boulders, but some visual impact will be unavoidable. After the project is completed, the removal of the conveyor will be followed by extensive site mitigation.

ROAD IMPROVEMENTS (YEARS 1 AND 2)

Road improvements on Evergreen and Hetch Hetchy Roads will be necessary for equipment mobilization and material hauling.

Evergreen Road, which currently supports truck traffic for logging operations, will accommodate both the weight and length of construction equipment and haul trucks. Mobilization of oversized equipment will require one-way traffic. Certain improvements will be required for safety, including trimming of dense undergrowth, striping of the road, and installing a temporary stoplight at the Highway 120 intersection.

The recently rebuilt bridge over the Middle Fork of the Tuolumne should be sufficient to support both the weight of loaded truck and transfers or bottom dumps and the volume of two-way traffic expected on Evergreen Road. It will be necessary to address safety concerns at the Camp Mather bypass and its new intersection with Hetch Hetchy Road at Camp Mather due to high pedestrian traffic at Camp Mather during the summer season. This bypass should be a temporary access road leading to the Camp Mather Staging Area. Mitigation for road impacts will be required during construction, and restoration of the route will be required when it is no longer needed. To the extent possible, construction and hauling will be conducted to minimize impacts on Evergreen Lodge.

Hetch Hetchy Road does not currently support vehicles over 25 feet in length. Since this is the only access to the dam site, improvements will be required to support mobilization of heavy equipment and general construction traffic. Because the road is located in Yosemite National Park, these road improvements should be held to the minimum required to allow the project to proceed.

Use of the conveyor belt to move debris will reduce the need for heavy truck traffic on Hetch Hetchy Road, but heavy truck traffic will be necessary on Evergreen Road. Hetch Hetchy Road will need to handle long loads, wide loads, frequent vehicle traffic required by mobilization and demobilization of equipment, and daily personnel transport. To minimize the necessary improvements and maintain the remote character of Hetch Hetchy Road, traffic controls will be implemented, including one-way traffic as necessary, restricted access, and worker shuttle service from the Camp Mather Staging Area. Improvements will include some straightening and widening of the roadway, installation of temporary safety barriers (K-rails) in critical areas, and new striping for traffic direction and control. Temporary measures will be used whenever possible to avoid permanent alteration of the landscape.

LOWERING OF RESERVOIR ELEVATION (YEARS 2 AND 3)

Hetch Hetchy Reservoir will be lowered to the desired minimum pool elevation during the late summer of Year 2. The released water will be used to replace normal releases from Don Pedro Reservoir, to replace groundwater usually pumped downstream, and/or to fill storage reservoirs in the Bay Area. During the period from the winter of Year 2–3 through the spring of Year 3, Hetch Hetchy Reservoir will be maintained at the minimum pool elevation. This will allow for the necessary construction and modifications at the entrance of the Canyon Tunnel, as well as the installation of temporary dewatering and control facilities for use during the demolition of the dam (see below).

This schedule allows for restoration to begin at the upper end of Hetch Hetchy Valley in the spring of Year 3.

DIVERSION OF TUOLUMNE RIVER (YEAR 3)

In order to minimize the negative impacts on water quality and aquatic habitats and the disruption of river flows, the Tuolumne River will be diverted

upstream from the dam site throughout the period when the dam is being demolished. Construction of the diversion will take place during low water (August–October) of Year 3. The diversion will be designed to work on gravity flow, but temporary pumping will be required to dewater the river during construction of the diversion. The dewatering system will include a temporary cofferdam, bypass pipes, and emergency control measures.

Cofferdam. A temporary cofferdam will be installed upstream from O'Shaughnessy Dam to divert the river into a pipe system, which will be constructed first. Installation of the cofferdam will require pumping the river water into the pipe system. The discharge may be through the original river bypass tunnel. The cofferdam will accommodate river flows up to a level that occurs no more than once every ten years, and it will be able to handle overflow during the winters of Years 3–4 and 4–5. All components will be installed in time to activate the diversion in the spring of Year 4.

Pipe diversion. HDPE fused pipe will be installed from the cofferdam to the entrance of the Canyon Tunnel. Installation of this pipe will require minor grading in the valley bottom to maintain a gravity flow.

DEMOLITION (YEARS 2, 3, 4 AND 5)

Dam demolition will be phased to allow for removal and salvaging of materials and operational safety.

Year 2 — Removal of electrical
Year 3 — Removal of hydraulics
Year 4 — Removal of hydraulics, demolition of internal structure, beginning of concrete demolition
Year 5 — Concrete demolition, crushing and removal

CONSTRUCTION OF NEW FACILITIES (YEAR 5).

In this year, all necessary new facilities in the valley will be built.

Environmental Mitigation during Construction; Sensitive Habitat Protection

For all road improvements and at staging areas and the dam site, habitat will be assessed for sensitivity to construction activities. Environmentally Sensitive Areas (ESAs) will be delineated for special protection measures, including the installation of temporary protective high-visibility fencing, solid fencing as barriers to sensitive species, and biological monitoring. All of these protective measures will be put into place at each site before construction work begins. Additional mitigation may also be required prior to construction at each site.

Sediment and Erosion Control Measures

Every effort will be made to prevent sediment caused by construction activities from entering waterways. A Stormwater Pollution Prevention Plan (SWPPP) will be required for every phase of construction. These plans will assess potential sources of contaminants that might affect water quality and identify Best Management Practices including, but not limited to, silt fences, straw bales, and temporary sediment basins.

Archaeology

Special attention will be given to preservation of Native American archaeological sites in the Valley. They will be fenced to prevent negative impacts

from construction, or from the planting of native plants during post-construction mitigation and restoration. A full-time ranger patrol will be assigned to protect these sites.

Aesthetics

Construction within and in close proximity to Yosemite National Park will require special measures to protect the aesthetics of the area. Many impacts will be unavoidable, especially at the dam site. However, construction impacts in high-visibility areas open to the public (especially Camp Mather and Evergreen Road) will be offset by screening, maintaining existing vegetation, assuring the orderly delivery and storage of material, and conducting vehicle fueling and the maintenance of equipment and staging areas in an orderly condition.

Noise

Increased noise in construction zones will be unavoidable. Mitigation measures will include mufflers on all construction equipment, straw bales or other noise barriers on any generators or stationary equipment, and keeping stationary equipment as far as possible from sensitive receptors such as campgrounds and Evergreen Lodge. Construction hours will be limited on a seasonal basis in areas of sensitive receptors. Dam site construction will be exempted from this requirement due to seasonal construction deadlines set by state and federal regulatory agencies.

Air Pollution

Air quality impacts are expected in the construction areas due to high volumes of construction equipment operating year-round for the five-year construction period. Numerous mitigation measures will be implemented, including but not limited to the following: shuttling of personnel to reduce personal vehicle trips, regular tuning of construction equipment, use of newer equipment with emission controls, limited idling of equipment motors, and carefully conducted fueling of vehicles and equipment. Alternative fuels such as biodiesel will be considered for possible use in construction equipment, and a zero emissions vehicle/low emissions vehicle (ZEV/LEV) requirement will be implemented for a percentage of construction personnel vehicles.

Fire Protection

Construction contractors and crews will exercise extreme caution in every phase of construction to reduce the risk of wildfires caused by construction activities. All heavy equipment will be equipped with spark arresters and fire extinguishers that will be regularly inspected by personnel trained in fire prevention. All small equipment will be located to reduce the risk of fire. Fire breaks will be established at the perimeter of the three staging areas. Personnel will not be allowed to refuel equipment outside the designated fueling areas. Smoking will be allowed only in designated smoking areas.

Hazardous Material Control

Assessment and control of hazardous materials (gasoline, diesel, lubricants, solvents, etc.) will be addressed in the Stormwater Pollution Prevention Plan (SWPPP) and in a separate Hazardous Materials Control Plan. This plan will stress the sensitive nature of this project and the importance of reducing the risk of hazardous material spills. Additional measures to control hazardous materials will include the employment of a trained hazardous materials control officer to conduct regular inspections and implement the Best Management Practices outlined in the SWPPP. This officer will be responsible for stocking cleanup materials in strategic locations, for familiarizing other personnel with the location and employment of the materials, and for training them in the proper responses to spills of hazardous materials. Furthermore, this officer will be responsible for posting emergency contact information and acting as a liaison with public authorities.

Conservation and Recycling

It is imperative that the components of the project reflect the progressive nature of the project as a whole. A key component of the project is the massive amount of "waste" materials generated by the demolition of the dam. However, these materials will not be considered for disposal as waste. Instead, they are a valuable resource as recycled materials.

- Concrete will be processed for reuse as aggregate base.
- Scrap Metal. All pipes and other recyclable metal will be salvaged for scrap metal.
- Miscellaneous Waste. A program will be put in place to collect recyclables from personnel operations and construction equipment.

Site Restoration

A restoration plan will be developed for all disturbed areas. Restoration techniques will include site stabilization and erosion control, road removal, restoring land contours (regrading), and revegetation. Establishment of revegetated areas will be monitored for a minimum of five years corresponding to the restoration monitoring of Hetch Hetchy Valley. Measures will be taken to avoid bringing seeds of invasive plants to the site. Any non-native plants which grow as a result of failure of this effort will be removed.

Dam Site Restoration

The dam site will require extensive restoration. River morphology restoration upstream of the dam site will be engineered along with the downstream tunnel diversion structure. Restoration measures below the diversion structure will include stabilizing the slopes and revegetating disturbed areas. The revegetation of the riparian zone and surrounding uplands will be addressed in the valley restoration plan.

All access routes except the designated maintenance route will be removed and restored to original grade. Regraded areas will be stabilized with measures such as erosion control fabric, hydroseeding and straw wattles. These areas will also be revegetated where feasible. The maintenance access route will be established in a visually subtle location and stabilized with measures such as outsloping, rolling dips, slope stabilization above and below road grade, and permanent sediment traps.

Restoration of Transportation and Haul Routes

Temporary roads to be established as haul routes and for transportation of personnel will be removed and regraded to original land contours. These areas will be stabilized with erosion control fabric and straw wattles on slopes greater than 2:1 and hydroseeded on lesser slopes or level areas. All temporary haul routes will be revegetated with a mix of native plants that will include grasses and understory and canopy species.

Restoration of Staging Areas

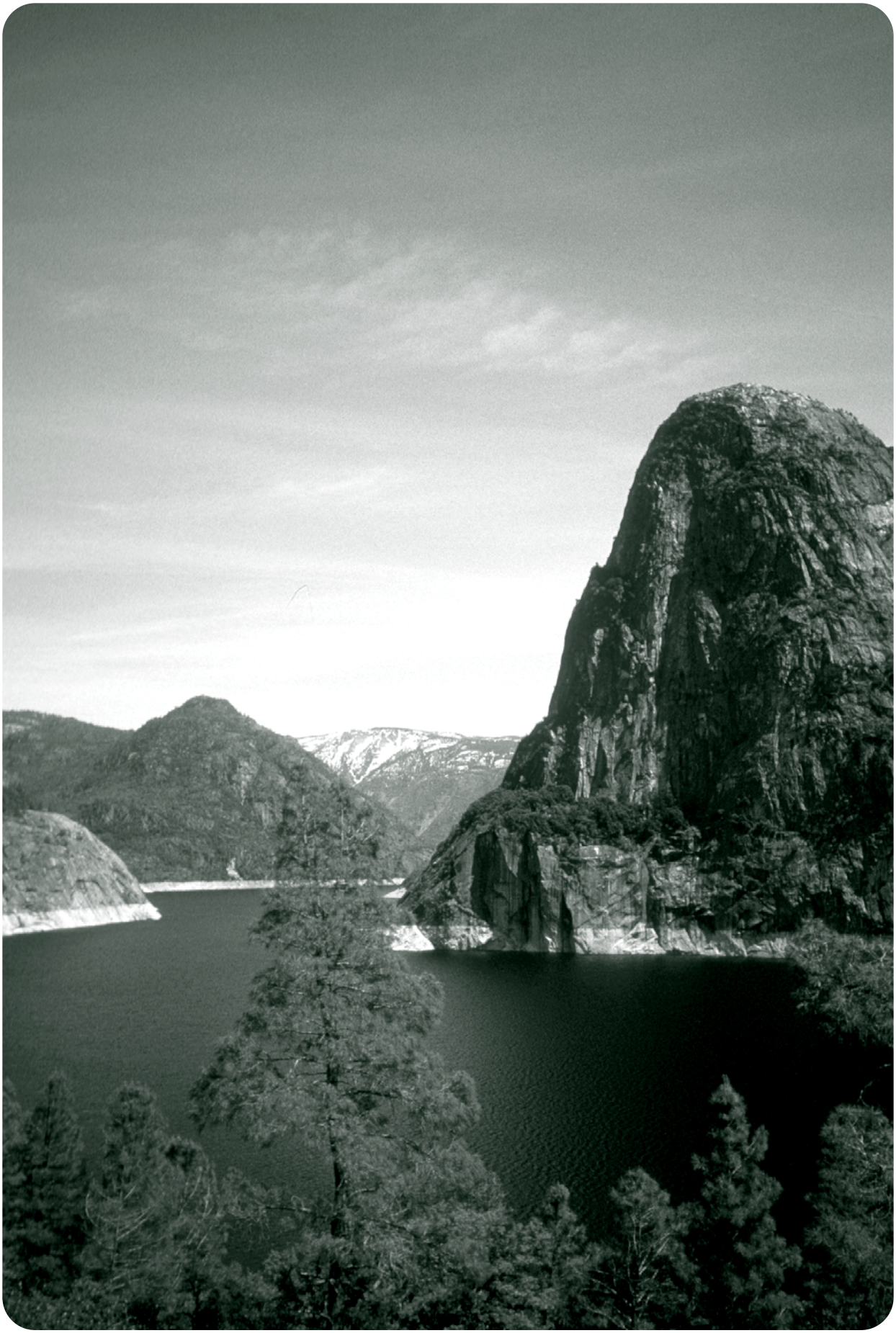
Temporary staging areas will be removed, regraded to original contours, and restored with native vegetation. Temporary protection of the restored sites will be provided while the planted native vegetation establishes itself. Slopes will be stabilized with fabric, wattles, and hydroseeding.

Cost

The total cost of dam removal and remediation of the sites and staging areas is estimated at $100 million. A detailed breakdown of these estimated costs is available from RESTORE HETCH HETCHY.

Jobs

Dam deconstruction will directly create 490 construction jobs for the five-year period and will stimulate the creation of a total of 4,210 jobs, including secondary employment effects (Federal Highway Administration figures)[xxiii].



Hetch Hetchy Reservoir - Jenny Ross

MEETING WATER NEEDS

San Francisco told Congress in the early twentieth century that building a dam in Hetch Hetchy Valley was necessary to furnish water for the city, which had outgrown its Bay Area water supply. But today, even after Hetch Hetchy Reservoir is removed, new water management methods combined with the construction of other water supply facilities will make it possible for San Francisco and its Bay Area customers to meet their water needs more efficiently. The water needs of the Modesto and Turlock Irrigation Districts (possessing some of the oldest water rights in California) can also be met after the removal of the reservoir.

RESTORE HETCH HETCHY wants to make sure that San Francisco and its customers are made whole, or even better off, with respect to power and water supplies once the reservoir is removed.

San Francisco claims that the firm yield of O'Shaughnessy Reservoir is 239 million gallons per day, or 267,680 acre-feet per year[xxiv]. Total firm yield of the entire Hetch Hetchy system is 306 million gallons per day, or 343,000 acre-feet per year. This includes the water from Eleanor and Cherry Reservoirs. (Firm yield is the amount of water that San Francisco can expect to obtain from the reservoir in a relatively dry year.)[xxiv] This is 18 percent of the nine Bay Area counties' water use[xxv], only 3 per cent of California urban water use[xxvi], and about 1 percent of total California water use.[xxvii]

FUTURE WATER NEEDS

At present, San Francisco diverts about 249,000 acre-feet a year from the Tuolumne River. Existing conveyance facilities would allow a maximum additional diversion of 89,000 acre feet per year. This would allow for more than 30 percent growth in water use in their service area.

San Francisco argues in its Capital Improvement Program[xxviii] that, due to urban growth in its service area outside the city limits of San Francisco, it will eventually be necessary to divert up to an additional 179,000 acre-feet per year, or 10 percent of the entire historic flow of the Tuolumne River, to meet these needs. This additional water is above and beyond the full use of their existing facilities, as discussed above. Since the city currently serves approximately 2.4 million people (in San Francisco, San Mateo, Santa Clara, and Alameda Counties), it can serve nearly an additional one million people by fully utilizing existing facilities. The city could serve an additional two million people beyond that with the proposed new facilities.

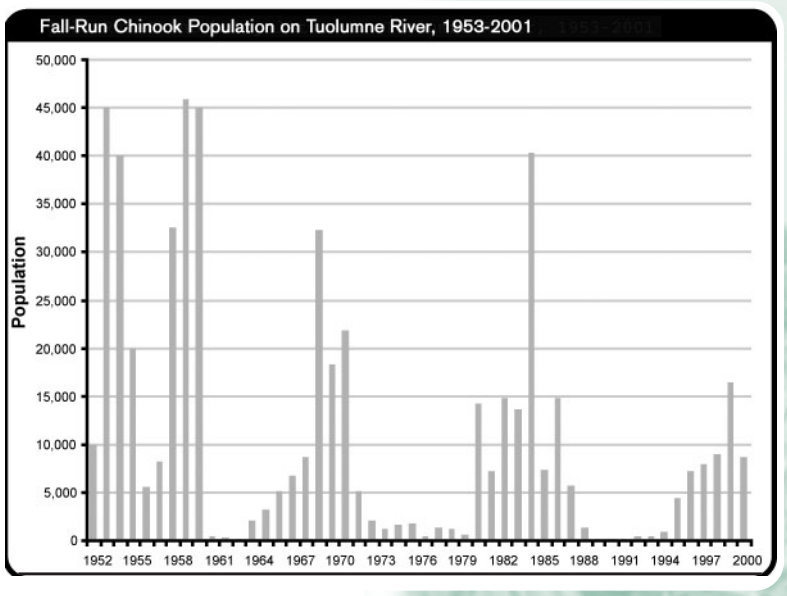
In other words, San Francisco proposes to eventually more than double the population of its service area — from 2.4 million to 5.5 million — with water from the Tuolumne. Even without Hetch Hetchy Reservoir, this population increase could be accommodated if better water efficiency, wastewater reclamation, and groundwater management practices were instituted.

The state Department of Finance[xxix] estimates that population growth in the San Francisco's service area will average about 0.5 percent per year. At this rate, it would take more than 140 years to double the population. The Bay Area as a whole grew about 1 percent per year from 1990 to 2000. Even at the 1 percent growth rate,

it would take 72 years for the projected doubling of the service area's population to occur. Nearly all this growth would be outside San Francisco.

See the discussion of water efficiency below for further insight into the validity of projections of future water needs by agencies that get their water from the Hetch Hetchy system.

There is an important question about whether continued urban growth in the southern and eastern portions of the Bay Area is a good idea or not, given the traffic congestion, air quality degradation, and loss of open space that such growth would cause. While the debate about growth in the Bay Area is beyond the scope of this report, RESTORE HETCH HETCHY rejects the argument that additional Tuolumne River water must be diverted to meet growth needs. A larger population need not result in increased consumption of water. Population in the Metropolitan Water District of Southern California has increased greatly in the past decade with almost no increase in total demand for water.



California Department of Fish and Game

If population growth comes about through urban infill — as opposed to suburban sprawl — any new water demand created by such growth will be relatively small. Regardless of the amount or location of population growth, RESTORE HETCH HETCHY does not believe that the Tuolumne River, already highly stressed both upstream and downstream from Don Pedro Reservoir, can support an additional diversion of more than half of its remaining flow. (See Table 1.)

For that reason, if it is decided that San Francisco water customers need more water than is currently being diverted from Bay Area and Tuolumne sources, the additional water should be supplied from even greater utilization of the alternative water sources discussed below — sources that do not require additional diversion from the Tuolumne.

Currently, as shown in Table 1, when San Francisco diverts what it is allowed to divert under their current water right, flows in the Tuolumne below La Grange Dam will average only 25 percent of their historical levels. Great damage has been caused by these reductions in flows and by the various impoundments on the main river and its tributaries. Runs of salmon and steelhead in the Tuolumne once numbered in the several hundreds of thousands; today, the runs consist of only a few thousand fish.[xxx]

While augmented summer flows from Holm Powerhouse have extended the whitewater boating season, desirable boating flows are curtailed when O'Shaughnessy Dam stops spilling, and when Cherry and Eleanor Reservoirs fail to provide boating flows and confine their releases to the bare minimum necessary for fish. Additional diversions will simply worsen conditions for fish and whitewater recreation.

Allocation of Tuolumne River water in average runoff years [1.] - Table 1

Diverter and Purpose	Present Amount taf/yr	Expansion Amount Fully Used taf/yr	Percent of Av Total Used in Past Av Years	Percent of Av Total With SF CIP Expansions Fully Used
TID and MID together. For Ag and M & I	908	908	46	46
Stream Release at La Grange For Salmon and Recreation	301	301	15	15
Evaporation From Four Reservoirs	54	54	3	3
Present Spill i.e. flood release at DP	463		23	
Spill with SF at full diversion capacity[2.]		195		10[5]
CCSF presently diverts 221 mgd	248	248	13	13
CCSF Unused capacity in SJPL No. 1, 2 & 3 is 79 mgd		89		**4**
SF CIP new San Joaquin Pipeline No. 4, Capacity Up to 160 mgd[3.]		**179**		**9**
Total Fifty yr av ending 1992[4.]	1,974	1,974	100	100

* San Francisco uses all the water to which it claims the right to divert from the Tuolumne

Footnotes:

1. For water years 1943 through 1992.
2. Presumes SF expansion all comes from spill, which empirically happens 2 to 4 times in 13 years.
3. The author presumes SF will take these flows from spills "--taking it during flood flows" (SF Chron., Oct 3, 2002, p A-1) in March through June into enlarged Calaveras Reservoir during better runoff years in every 13-year rainfall cycle. Present reservoirs have little carryover capacity for unallocated water (spill water).
4. Calif. Department of Water Resources (DWR) data from TID. Total presumes future runoff will be same as in the past, unaffected by global warming. Average for years 1922 through 1992 is 1,789,000 af/y.
5. In years with less than 90% of average runoff, one or more uses or users of water may start suffering a shortage.

Other Notes:

TID and MID are Turlock and Modesto Irrigation Districts. Ag, M & I are agricultural, municipal and industrial. Definitions: taf/y is thousand acre-feet per year. mgd is million gallons per day. SF is San Francisco. A water year is Oct 1 through Sept 30 of the following year when most precipitation occurs, runoff flows into rivers, is collected in reservoirs, generates electricity and is diverted to one of the uses or is released on down the river below the reservoir for stream purposes. For 400 mgd expanded diversion minus 239 mgd firm yield of HH Res =161 mgd. The balance would be expected to be drawn from Cherry/Eleanor Reservoirs if they have that much firm yield. The 161 mgd is equivalent to 249 cfs (179 taf/y) reduced flow below Cherry Cr confluence. Present capacity of Lower Cherry Cr Aqueduct is 150 cfs (97 mgd) and expansion is limited by Raker Act. Water from Cherry and Eleanor reservoirs has no filtration avoidance waiver.

OPTIMAL ALTERNATIVES

There are many options for ensuring an adequate water supply for San Francisco and its customers. After the reservoir is removed, at least each of the following steps is likely to be taken:

- Diverting and pumping water from below the dam site into the Canyon Tunnel.
- Increased efficiency of water use
- Wastewater reclamation (recycling)
- Pumping water from Cherry Creek below Holm Powerhouse into the Mountain Tunnel

Diverting Water from below the Dam Site after Removal of the Reservoir

While Hetch Hetchy Reservoir will be entirely eliminated, water from the Tuolumne River could still be diverted into the Canyon Tunnel, [xxxi] which leads to Kirkwood Powerhouse (Figure 1, page 2). A pump station about a half mile below the existing dam site would lift water about 60 feet into the Canyon Tunnel. Only the water not needed for instream flows to support fish, wildlife, and recreation would be diverted. The pump station and diversion weir would cost around $52 million. Modifications to the Kirkwood turbines and generators plus automation and watershed telemetry costing less than $20 million would be required. For every kWh used for pumping this water into the tunnel, 6 kWh would be generated at Kirkwood Powerhouse.

There is a hump in the Canyon Tunnel that rises 50 feet above streambed elevation in the valley. The hump is seldom a problem now since the reservoir level is kept above that hump. After the dam is removed, pumping from the river below the dam into the Canyon Tunnel will overcome the problem. This will allow water from the river to be used to generate power at Kirkwood Powerhouse.

The proposed diversion of additional water from below the dam site into the Canyon Tunnel would be almost invisible from Hetch Hetchy Valley and would intrude little on the natural scenery. A fish screen would keep fish and debris out of the pumps.

The amount of water that could be captured through this diversion would vary greatly depending on the season and the type of water year. In high-runoff years the Canyon Tunnel could be kept flowing at relatively full capacity from December well into July, and significant amounts of water could be diverted during those months, while instream flows would still meet downstream fish preservation and water quality standards and support recreation. In drier years, substantially lesser amounts of water would be diverted into the Canyon Tunnel, and shortfalls in supply would be met by employing the alternate means discussed below.

Currently, a maximum of 1,391 cubic feet per second (cfs) can be diverted into the Canyon Tunnel. The same maximum amount could be diverted into the Canyon Tunnel after the dam has been removed. Table 2 (pages 24A & 24B) shows diversions in a median year, with and without the reservoir. If water is pumped from below Holm Powerhouse (as discussed below) into the Mountain Tunnel, there would be no loss of water supply in a median year even with the Hetch Hetchy Reservoir removed. In a dry year, there would be a need for supplemental water.

Another option would be not to divert water into the Canyon Tunnel, but to abandon that facility and let all the water flow down the river channel to Early Intake Reservoir. This option would greatly reduce power generation — by an estimated 267 million kilowatt hours per year, costing around $15 million per year (Table 2). Some would prefer this option, since it would leave the river downstream of Hetch Hetchy Valley in a more pristine condition.

A final option would be to divert the water at the O'Shaughnessy dam site into a tunnel discharging into the Canyon Tunnel. This six mile long tunnel would cost ten times as much as diverting from the river downstream. This plan would also required leaving 20 feet of the dam in the river to divert water into the tunnel (cost data from Appendix A, Table 8, Environmental Defense report [xliii]).

With any option, the same amount of water would be available for generation of energy at Moccasin Powerhouse and for export, since water not captured at Hetch Hetchy will be captured downstream at Early Intake.

Water Efficiency

RESTORE HETCH HETCHY uses the term "water efficiency" instead of "water conservation" because saving water is generally an economically sound practice, and because "water efficiency" more precisely describes the change in water use practice that should take place if economic savings are the goal.

Increased water efficiency should play a key role in replacing the Hetch Hetchy Reservoir water supply. Water efficiency should be aggressively pursued in outdoor irrigation, indoor domestic, and commercial and industrial uses. Not only is water efficiency highly cost-effective, but reduced use of hot water can also produce great energy savings. Water efficiency could save additional energy costs, since most municipal water must be pumped uphill to serve customers. The first priority in the water efficiency program should be to implement efficiency in the homes of low-income residents, who often have the least efficient showerheads, toilets, faucets, and appliances.

Interestingly, water rights attorney Stuart Somach makes the argument that the Raker Act could be interpreted to oblige San Francisco to conserve water before exporting water from Hetch Hetchy.[xliii] He notes that the first agreement between the irrigation districts and San Francisco finds that water must be "properly conserved" by San Francisco.

Maximum water efficiency is the most cost-effective means of replacing water supplied by Hetch Hetchy. The proposed level of water efficiency is high. That does not mean that these projections are impractical. They were largely developed by a contractor to the California Department of Water Resources, as described below. Water efficiency at this level would require a significant investment, but that level of investment would be lower than that required by many other water supply options.

Implementing water efficiency now is the best means of "drought proofing," since water that is now used could be kept in storage, making more water available when a drought arrives.

The Metropolitan Water District of Southern California has greatly expanded its exemplary water conservation program[xxxii]. The district notes that enormous savings can be realized through the use of computerized outdoor irrigation systems that turn on only when lack of rain has caused a deficit in soil moisture. Many existing systems irrigate on a regular basis, rain or shine, needed or not.

Another fruitful source of water savings is indoors in homes, apartments and hotels. Many showers and faucets use far more water than necessary. Huge amounts of water and energy could be saved by replacing old washing machines with newer, front loading energy efficient models. Although only low-flow toilets can now be purchased, hundreds of thousands of the old, wasteful models are still in use. In addition, leaking toilet float mechanisms add to the losses. To the extent that master meters still exist in multi-family housing, replacement by individual meters should result in greater water efficiency by making individuals and families pay for their own consumption and thus giving them an incentive to conserve.

Industrial use of water in the San Francisco service area is not substantial, and it is already quite efficient. Nevertheless, by increasing internal factory re-use of water and by developing processes which use less water in the first place, factories could save much additional water. There are substantial opportunities for saving water in commercial establishments such as hotels, restaurants, and office buildings.

Energy Produced Before and After Hetch Hetchy Reservoir Is Relocated - Table 2

This work is based on flow calculations during SF Fiscal Year and Water Year 1979, a near median runoff year at Hetch Hetchy following a WY with 145% of average runoff year. Stream release alternate based on SFPUC 1981 " Appendix A" for recreation in summer. A fall stream release was added by the author. Pump station ca 3490 ft elevation, downstream from HHV pumps water into Canyon Tunnel for generation at Kirkwood.

	Present O'S Dam height 3812 ft elev. Base Case					O'S Dam height 3500 ft elev. pump station 1/2 mile downstream. With A Holm Pumping Station No Stream Release Requirement				O'S Dam height 3500 ft elev. pump station 1/2 mile downstream. With A Holm Pumping Station With a Stream Release Requirement			
Monthly Sheets													
Col Reference >	**D**	**I**	**AS**	**W**	**AR**	**O**	**AW**	**AZ**	**AV**	**O**	**AN**	**AL**	**AP**
By Month	Kirkwood Had 2 Generators In 1979	Kirkwood Has 3 Generators Presently*	Moccasin Actual Generation	Holm Actual Generation	Av Flow Available For Export At Moccasin	Kirkwood 3 Run-of-the-river Generators. Gain Over Pumping Energy Used****	Moccasin Generation Gain Over Pumping Energy Used***	Holm Generation	Av Flow Available For Export At Moccasin	Kirkwood 3 Run-of-the-river Generators Gain Over Pumping Energy Used****	Moccasin Generation Gain Over Pumping Energy Used***	Holm Generation	Av Flow Available For Export At Moccasin
Fiscal Year	**MKWh**	**MKWh**	**MKWh**	**MKWh**	**cfs**	**MKWh**	**MKWh**	**MKWh**	**cfs**	**MKWh**	**MKWh**	**MKWh**	**cfs**
'78, '79													
July '78	53.507	90.914	44.353	85.493									
Aug '78	53.081	47.676	44.015	73.127									
Sept '78	51.374	46.144	42.599	64.027									
Water Year 1979													
Oct '78	54.005	54.306	44.748	67.475	638.1	1.149	29.394	91.788	655.71	1.149	29.393	91.62	655.71
Nov '78	52.119	52.396	43.191	68.467	635.97	1.795	28.184	93.767	642.33	1.795	28.184	93.767	642.33
Dec '78	53.593	53.818	44.421	77.553	632.26	6.073	30.435	87.23	643	6.073	30.435	87.23	643
Jan '79	53.605	54.17	44.431	85.227	632.39	17.391	34.883	71.053	628.13	17.391	34.883	71.053	628.13
Feb '79	48.42	48.871	40.133	77.282	632.43	17.82	33.734	67.479	684.68	17.82	33.734	67.479	684.69
Mar '79	53.68	54.192	44.941	75.209	633.45	36.101	43.112	39.358	666.71	36.101	43.112	39.357	666.71
Apr '79	51.715	49.09	42.87	84.784	630.03	47.79	44.927	21.3	673.17	47.79	44.927	21.3	673.17
May '79	52.875	84.66	43.851	75.118	622.06	56.809	47.21	0	683	56.809	47.209	0	683
June '79	51.432	80.796	42.646	71.51	625.9	54.69	45.687	44.039	683	54.69	45.687	43.917	683
Fiscal Year													
78-'79 Total	629.406	717.033	522.199	905.272									
HH Ann Report	668.383		548.385	902.022									
% Difference	-5.8 %		-4.8%	0.4%									
July '79	52.985	54.337	43.938	57.674	623.61	27.537	37.249	83.763	579.9	27.537	36.044	82.453	564.98
Aug '79	52.699	52.781	43.71	57.368	619.58	0.444	22.316	125.682	461.39	.444	20.961	123.961	454.55
Sept '79	50.888	51.05	42.212	54.201	617.97	0	24.639	106.957	571.4	0	24.163	105.314	577.18
WY '79 Total	628.016	690.467	521.092	851.868	628.6	267.599	421.77	832.416	630.5	267.599	418.732	827.451	628.6

Summary:

						3rd Alternate
*Sum for 3 present powerhouses	2063.465		1521.785		1513.782	1246.183
Change in Base Case in MkWh/y			**-542**	1.9 cfs	**-550** 0 cfs	-817
% Change			**-26.3**	0.3%	**-26.7** 0%	-40
Cost of replacing lost energy at a guess of 55 $/MWh would be			**29.8 million $ a year.**		**30.3 million $ a year.**	45

3rd Alternate

O'S removed, no diversion at HH Valley, no pump station, no generation At Kirkwood. Generation same at Moccasin & Holm and export same as in stream release alternative. Only change is in MkWh/y and dollar value of energy reduction per year.

Energy Produced Before and After Hetch Hetchy Reservoir Is Relocated - Table 2

Comparisons between configurations are valid because they are based on the same flows and energy is calculated using the same equations, in spite of the fiscal year calculated totals not matching HHWP annual report year totals by about -5%. This in spite of using the full height of present O'S & Cherry for energy calc.

The major feature of this presentation is the addition of a pumping station downstream from Holm Powerhouse outfall to move a portion of Cherry/Eleanor water into Mountain Tunnel to compensate for less diversion from flow at O'S Dam and/or at Early Intake Reservoir to preserve low dissolved solids Sierra source water for export. Sverdrup & Parcel and Associates and other firms were first to suggested a pumping station in their two June 1981 "Systemwide" reports.

SF Fiscal year is July 1 through June 30 following. A Water Year is October 1 through Sept 30 following.

Results for all months are calculated on a daily basis using data in HHWP form P-173 sheets number 271 through 286 as the base case and in constructing the alternatives impact on power generation. These data were provided by Leo Bower at HHWP in October 1985.

*Kirkwood Powerhouse is shown with 3 generators in the base case to make the comparison reflect the current situation. A third generator was added in 1988. ****A run-of-the-river operation at Kirkwood for a lowered O'S is calculated daily based on inflow at Hetch Hetchy shown in form P-173. A pumping plant would be located just downstream of the former dam to pump into Canyon Tunnel. Pumping energy is subtracted from powerhouse generation. Crest elevation of present O'S is 3812 ft above sea level. In the alternatives, O'S would be lowered by 312 ft to ca 3500 ft elevation, leaving the outlet lip just above streambed Historic streambed at HHV is 3500 ft elevation. If a new tunnel entry option is chosen, ca 20 ft of dam would be left to move water into the new tunnel entry.

HHWP explained flow from O'S will stop at elevation 3550 ft in the present dam (private communication). There are at least two way to decrease the loss in power at Kirkwood and ultimately at Moccasin which are: Pump from TR into Canyon Tunnel at HHV or just downstream, or bore a new tunnel entry for ca 6 mile to bypass the small valves, twisting tunnel and hump at 3550 ft in the main tunnel. Pumping from Tuolumne R downstream from HHV reduces energy most, so that was chosen for this conservative analysis This "HH Adit pump station" would consume about 21 Mw of energy at full tunnel flow and cost about $ 52 million to build.

Minimum flow for generation at Kirkwood is chosen as 15% of one generator, 39 cfs for the dam at 3500 ft. Stream release has first call on flow and is 35, 75 or 115 cfs depending on season and draft. Max generation flow is set at 1391 cfs with excess at Hetch Hetchy Valley adding to stream release. No generation is shown for Kirkwood unless usable flow is available for a minimum of 2 days. This presumes that major tribs will have flow rate telemetry in the future for predicting flow expected on the following day.

Base case generation in WY 1979 is higher than other median WY, like 1971, because WY 1979 began with an unusually large carryover at HH Reservoir. Leo Bower at HHWP warned of this problem for comparisons in 1985 (private communication). Thus energy decrease calculated here are higher than in the ideal median year case, perhaps WY 1971.

Goal is to supply the same total cfs/y (af/y) to Moccasin as in the actual WY 1979 operation, the base case, when average flow to Moccasin was 676 = (628.6 + 47).

Average Flow Available For Export At Moccasin shown has had 47 cfs deducted from gross flow to allow for use by Groveland Community Services District, for domestic use at Moccasin, for a large flow to Moccasin Fish Hatchery and for losses from Mountain Tunnel (Sverdrup et al, Systemwide Study, June 1981).

SFPUC no longer lists any firm power for their generating system due to the state law placing all reservoirs on a "water supply firsf' basis.

Holm in the past has operated largely for peaking, but would be used for water supply and stream flow primarily in the pumping transfer scenario shown with a lowered O'S.

To produce replacement of 550 MkWh/y reduction shown in the recreation release option, roughly 140 MW of replacement power must be provided elsewhere. If the load factor on the replacement generation would be 45%, roughly 11 hld full load operation every day would be indicated. Somewhat more replacement generation is needed if PV is chosen as the replacement. ***Energy produced at Moccasin Ph has been decreased by the energy used at Holm Pumping Station to move water to Mountain Tunnel.

For Cherry/Eleanor there is no analysis of firm yield, or raising Cherry, or larger pumps in the Eleanor-Cherry Tunnel, or transfer of excess from Canyon Tunnel. Water drawn from Cherry/Eleanor in these scenarios is exactly that which was actually with-drawn. This is shown in Sept worksheets as a zero sum in cell AT36. Water available for export at Moccasin is exactly that actually available as shown in cells base case & recreation flow collumns above. Both comparisons are valid.

Peaking power production at Holm is not emphasized in any alternative which is different from past operation. Replacement sources could provide peaking.

Equations used to derive numbers in this table are shown in "Sept daily worksheets", part of Excel file titled: RHH Kirkwood Energy JulyAugSept'79, 2-04

Recreation stream release was patterned after "Appendix A" which is a recreation flow supplement specifically requested from Sverdrup & Parcel and Associates and others firms who produced two "Systemwide" reports for the SF PUC in June 1981. Appendix A was provided by the late Dean Coffey, then General Manager of HHWP and later Acting General Manager of SFPUC.

A MkWh is a gWh, but readers not familiar with gWh are given an easier way of thinking in terms of million kWh rather than a new unit for billion Watt hour.

For a water year, 2615 data entries are required on a total of 12 monthly sheets to produce the results shown in this table.

The California Department of Water Resources has commissioned a comprehensive report on California's potential for urban water conservation. The report, *Waste Not, Want Not, the Potential for Urban Water Conservation in California*, published by the Pacific Institute in 2003[xxxiii], carefully examines the potential for water savings in indoor residential, outdoor residential, commercial, and industrial water use. The report contains enough information about San Francisco in particular and the Bay Area in general to allow reasonable estimates of the potential for water efficiency.

Water conserving appliances

To determine the potential for water efficiency in the San Francisco service area, the Pacific Institute report data was combined with data provided by San Francisco and the Bay Area Water Supply and Conservation Agency (BAWSCA) on current patterns of water use by residential, commercial, and industrial customers. Estimates, presented below, are conservative. They do not take into account the following factors, which could increase the efficiency potential in the service area:

- Because the service area contains many older residential and commercial buildings, it is likely that many plumbing fixtures are less efficient than comparable buildings in areas with more recent construction.
- According to the California Urban Water Conservation Council[xxxiv], fewer than half the agencies using Hetch Hetchy water are members of the Council. Those who do belong are supposedly committed to best management practices in water efficiency. In fact, they have done less to implement water efficiency than many other agencies, especially those in Southern California. Although the agencies in the Hetch Hetchy service area have slightly lower per-capita use than other agencies throughout the state, this is due mainly to the mild climate and smaller lot size found in these agencies' jurisdictions. If an analysis were performed taking these factors into account, actual current per-capita use would probably be higher than the state average.

Some 82 percent of residential water use in San Francisco takes place indoors, as compared to 67 percent in the East Bay Municipal Utility District, which is probably comparable in many ways to the Bay Area Water Supply and Conservation Agency (BAWSCA) members (San Francisco's water customers) that provide Hetch Hetchy water to consumers. It is important to recognize that this situation actually increases the potential for water efficiency in the Bay Area since according to the Pacific Institute report there is generally more potential for indoor water savings than for outdoor irrigation savings. The BAWSCA members report spending less than $1 million per year on collective conservation programs, less than a dollar per person per year.

Water conserving garden

Table 3 indicates the potential for urban water efficiency in the service area.

A conservative estimate of total potential water savings in the service area is 123,767 acre-feet per year. Compared to current use, this would be a savings of 44 percent. This projection is realistic. From 1970 to

1990, per capita water use in Southern California has actually declined somewhat[xxxv]. In contrast, BAWSCA projects an increase in water use of 17 percent by 2030[xxxvi], even though population is projected to increase only 13 percent.

The BAWSCA projections ignore not only the huge potential for water efficiency in their service area, but also their own history. Per-capita residential water use in their service area was 115 gallons per day in 1975 (before the 1976–1977 drought) and 104 gallons daily before the drought that began in 1987. Today it is only 93 gallons.

Given the huge additional potential for water efficiency that still exists, why should BAWSCA be projecting an increase in per-capita domestic use? Such an increase is especially unlikely because consumers face higher water bills in the future due to the cost of financing and carrying out much-needed repairs to the Bay Area's part of the Hetch Hetchy system. Of the $4.3 billion needed for repairs to the Hetch Hetchy system, more than $2 billion will be paid by BAWSCA customers. The average monthly residential bill in San Francisco, for example, is expected to increase from $13.28 in 2002 to $50.07 in 2015, largely due to the costs of the Capital Improvement Program. This cost increase of 10.75 percent per year is almost certain to result in lower water use. (Figures from the San Francisco Public Utilities Commission were obtained from the Capital Improvement Program page on the San Francisco Public Utilities Commission web site.)

BAWSCA and San Francisco are undertaking a detailed study of the potential for water efficiency in their service areas, and their projected need for water may be substantially reduced as a result of these studies.

As the Pacific Institute report points out, water efficiency is highly cost-effective. Most methods, such as installing low-flush toilets and efficient appliances, save not only water but also energy. The savings in water and energy costs to the consumers will be far larger than the cost of the program.

The total cost of implementing the water efficiency program needs to be determined based on a detailed study. While that study has not yet been carried out, it appears from the Pacific Institute report that the water can be conserved for less than $400 per acre-foot. Consumers should see considerable net savings in water and energy bills, depending on how much the program is subsidized by non-ratepayer funds. Under the financing mechanism suggested in the energy section of this report, the savings would be shared with the customers, so that half the savings would be used to finance revenue bonds. Only half the net costs of water efficiency would be paid for from governmental sources.

Consumer water bills may not be greatly affected by the implementation of the efficiency program, since most costs over the next 10-20 years will be associated with the costs of the Capital Improvement Program, designed to repair the aging water delivery system.

Water Efficiency Potential (Water Recycling)

For many years, water from wastewater treatment plants has been purified and used for a wide variety of purposes throughout the world.

One of the very first wastewater reclamation facilities was Stowe Lake in San Francisco's Golden Gate Park, which treated water that was then used to irrigate the park's lush vegetation.

Unlike many other agencies, San Francisco did not go much further than Golden Gate Park in its wastewater reclamation program. (A minor amount is recycled for truck washing at the Southeast Water Pollution Control Plant, although hydrants are usually used.) While water agencies in Southern California, the Central Valley, and parts of the East and South Bay were making enormous strides in recycling their wastewater, San Francisco and most peninsula water agencies did virtually nothing. Most golf courses in San Francisco's service area are irrigated with potable water, while many golf courses in Southern California and elsewhere in the state are irrigated with recycled water. Several agencies in the Hetch Hetchy service area are considering the use of reclaimed water for golf course irrigation. Three private courses around Lake Merced (Olympic Club, San Francisco Golf and Country Club, and Lake Merced Golf and Country Club) have signed contracts calling for them to take at least 75 percent of their needs from a new tertiary treatment plant in Daly City.

Recycled wastewater cannot be used for domestic consumption, but it can be used for many other purposes: almost all types of irrigation, numerous industrial processes, cooling towers for air conditioning and refrigeration systems, groundwater recharge, and others. Recycled wastewater can also be applied to indoor non-consumptive uses such as flushing toilets. The San Francisco Bay Area Regional Water Recycling Program[xxviii] has estimated that the potential for increased use of wastewater in the parts of the Bay Area served by San Francisco is 45,600 acre-feet per year, or 17 percent of the water needed to replace Hetch Hetchy Reservoir's dry-year supply. The average cost is $425 per acre-foot for near-term projects and $738 for medium-term projects, for an average cost of $582 per acre-foot.

The San Francisco Capital Improvement Program approved in 2002 contains $145 million for water reclamation and groundwater recharge in San Francisco[xxxviii] In late 2003 the San Francisco Public Utilities Commission (SFPUC) staff estimated the potential for water reclamation in San Francisco to be 13.5 million gallons per day, or 15,000 acre-feet per year. This appears to be consistent with the overall service area estimate cited above. RESTORE HETCH HETCHY estimates the cost of a minimal water efficiency and reclamation program to be about $77 million.

Pumping Water from below Holm Powerhouse into the Mountain Tunnel

One way to maximize power generation in a post-Hetch Hetchy Reservoir system would be to send as much water as possible through the Mountain Tunnel to Moccasin Powerhouse. It would be possible to capture up to 730 cfs of the water released from Dion R. Holm Powerhouse that was not needed for recreation, fish, or wildlife purposes and pump that excess directly into the Mountain Tunnel. (See Figure 1.) This project, first suggested by a San Francisco consultant[xxxix], would generate an additional 159 million net kilowatt-hours in a median runoff year (i.e., 159 million kWh more than the energy used to pump the water into the Mountain Tunnel). This additional water would replace, in a median year, all the water that would otherwise

WATER CONSERVATION AND EFFICIENCY POTENTIAL IN SERVICE AREA - Table 3

Potential Conservation projections from Pacific Institute Report

ALL WATER USE IN ACRE FEET PER YEAR (AFA)

	population	HH water use	local water	total water use all sources	RESIDENTIAL % of total	gp/c/d	AF	cons %	cons AF	COMMERCIAL % of total	AF	cons %	cons AF	INDUSTRIAL % of total	AF	cons %	cons AF
BAWSCA	1653618	191067	94618	285634	60	93	170240			16	44027	0.39	17171	8	23520	0.39	9173
estimated indoor potential conservation							114061	0.40	45624								
estimate outdoor potential conservation							56179	0.32	17977								
San Francisco	764049	87360		87360	65	66	56370			35	30990	0.39	12086				
estimated indoor							46223	0.40	18489								
estimated outdoor							10147	0.32	3247								
Grand Total	2417667	278427	94618	372994			85338				29257						9173
																total conservation	123767
																Potential savings of water from HH: 44%	

BAWSCA is Bay Area Water Water Supply and Conservation Authority: San Francisco's customers
16% of BAWSCA water use is unaccounted for
Industrial use probably includes agricultural water use, at least in Coastside Water District
from BAWSCA Annual Survey 2001-2002

	BAWSCA	population
	2002	1653618
Projected	2030	1878795
	% increase	13

	AFA Sf water	
	2005	200480
Projected	2030	235200
	% increase	17

Historic BAWSCA residential water use

Date	gal/per capita/day
1975	115
1986	104
2003	93

Gross per capita water use: 154 gp/c/d. includes commercial and industrial and losses
Total use is 255 mgd or 285600 AFA includes non-HH sources
Projected reclaimed water offsetting drinking water: add'l 2.5 mgd, or 2800AFA
(residential water use/population)
EBMUD water use: 67% indoor, 33% outdoor
BAWSCA water use is probably 100% of EBMUD interior use, and somewhat less outdoor due to climate and older lot size
Conservation Potential (%Savings) from Pacific Institute Report

San Francisco
SF is 82% indoor, 18% outdoor
SF water use: 102 g/p/c/d
from UWCC website: SF commercial industrial use is 30990 AF, making residential use 56370 (87360-30990)
SF residential use 67gallons/capita/day

Statewide Residential 134 gp/c/d (DWR Bulletin 166)
1 mgd = 1120 af/yr
1 acre foot per year=893 gallons/day

have been supplied from Hetch Hetchy Reservoir to the San Francisco service area. RESTORE HETCH HETCHY estimates the cost of this pumping plant and pipeline at $76 million. This is a part of RESTORE HETCH HETCHY's preferred option, one that preserves energy and water supply. It also does the most to provide San Francisco's customers with the highest quality water. This option does reduce revenue from the sale of peaking power.

After removal of the reservoir, it is important that the Hetch Hetchy water system be operated in a way that provides sufficient flows in Cherry Creek and the Tuolumne River for the traditional recreational uses of fishing and whitewater boating. Authorization of this pumping plant project would have to include safeguards to protect these recreational flows. Except in the driest years, flows at the confluence of Cherry Creek and the Tuolumne River should be at least 1,200 cfs for six hours per day, including weekends, at least through the Sunday after Labor Day. Flows should always be sufficient to keep resident fish healthy. San Francisco Hetch Hetchy Water and Power's General Manager previously stated recreational flows are feasible as mitigation[xl]. In a median water year, providing this flow costs $500,000 for energy replacement compared to no recreation flow, as shown in Table 2 under the alternates "No Stream Release Requirement" vs. "With a Stream Release Requirement."

To add to the amount of water available for diversion into the Mountain Tunnel, it is possible to use the existing Lower Cherry Aqueduct from Cherry Creek to Early Intake Reservoir. However, this aqueduct is very small and bypasses the generators at Holm Powerhouse. This canal should be used only during periods when the pumping station, power tunnel, or both are shut down for maintenance. All required flows for water quality, recreation, and fisheries would have to be met before water could be diverted into the pumping plant or aqueduct.

The federal Environmental Protection Agency (EPA) has not provided San Francisco with the right to use water from Cherry Reservoir for domestic use without filtration. RESTORE HETCH HETCHY believes filtration is required in any case, for all Tuolumne River water (see Water Quality section).

ADDITIONAL WATER SUPPLY OPTIONS

Many additional water supply options are available. Some of them use essentially the same water. For example, water from the Tuolumne River could be stored in an enlarged Don Pedro Reservoir, an enlarged Calaveras Reservoir, an enlarged Cherry Reservoir, or stored as groundwater. Once it is decided to move forward with the removal of Hetch Hetchy Reservoir, decisions will have to be made about which alternatives have the fewest environmental effects and are the most cost-effective.

Some of the options presented here are similar to those suggested by the Bureau of Reclamation in 1988[xli] in its analysis of options in conjunction with the removal of Hetch Hetchy Reservoir.

Without the reservoir, but with the diversion below the dam site and the Holm-Mountain Tunnel diversion described above, there would be no reduction of water supply in a median year (Table 2). There would be deficits in dry years, depending on the severity of the drought. An addi-

tional 169,367 acre-feet can be conserved and recycled in the Bay Area. These supplies can reliably meet dry year demands. A detailed analysis of 1979, a median water year, is available from RESTORE HETCH HETCHY. It illustrates how Table 2 was derived.

There are several additional water supply options beyond efficiency and reclamation that could be considered. The exact amount of additional water needed in a very dry year to replace the Hetch Hetchy Reservoir supply will have to be determined by an operation study. Certainly the amount needed cannot exceed the firm yield of the system, which San Francisco claims is 268,000 acre-feet per year.[xlii]

As pointed out earlier, if additional water supplies are needed to provide for growth in the service area, these options would also be available to provide the needed water.

Option 1

Use of Don Pedro Reservoir and Expanded Groundwater Capacity

Both UC Davis and Environmental Defense have completed rigorous studies using computer-based simulation models to evaluate how water delivery objectives in the Bay Area and to the Turlock and Modesto Irrigation District can be met without Hetch Hetchy Reservoir. These studies show how reoperating other reservoirs in the Tuolumne watershed, especially Don Pedro, which holds nearly 6 times as much water as O'Shaughnessy Dam, could play a key role in delivering water to the Bay Area.

First, Don Pedro Reservoir could be re-operated to allow diversion of water to Foothill Tunnel from the reservoir. It would be necessary to build an intertie between the reservoir itself and the Foothill Tunnel, which passes directly beneath the reservoir (see Figure 2). Building this connection will require cooperation of the Turlock and Modesto Irrigation Districts. It would be possible to build a filtration treatment plant at the reservoir, or to filter and treat the water after diversion to the Bay Area. (See later discussion of water quality.)

Environmental Defense Study

The Environmental Defense study [xliii](*Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley*, 2004) employs the TREWSSIM model, specifically developed to investigate alternatives to Hetch Hetchy Reservoir. The TREWSSIM results show that the system's other reservoirs could fully meet the needs of all water users in 80% of all years, without diminishing carryover storage. In the driest 20% of years, some additional supplies or contingency plans would be needed to ensure reliability. Environmental Defense specifically investigates the role that enlarged local storage, groundwater banking or transfers could play in ensuring equivalent water supply reliability, and acknowledges that other options, such as increased efficiency and reclamation, could be employed as well.

Sarah Null UC Davis Study [xliv]

A second way to meet all existing water needs from the Tuolumne without the presence of Hetch Hetchy Reservoir has been developed by Sarah Null, a graduate geography student at the University of California, Davis, under the direction of Professor Jay Lund. Ms. Null suggests meeting the water needs of San Francisco and its customers from Don Pedro Reservoir and the upstream water system, while fulfill-

ing the irrigation requirements of the Modesto and Turlock Irrigation Districts through the creation of a conjunctive use program of surface and groundwater.

In her plan, the irrigation districts would rely entirely on the river in wet and normal years, but turn to locally plentiful groundwater supplies during dry years. The groundwater would be naturally replenished from irrigation and the flow of the river during subsequent wet and normal years. No special groundwater replenishment facilities would be needed, although in order to utilize the groundwater fully, many additional wells would have to be installed.

This plan makes a lot of sense, since the groundwater table beneath the Turlock and Modesto Irrigation Districts is very full. If the districts turned to that groundwater during dry years and then allowed the storage to refill in wet years, they would need to rely less on diversions from the Tuolumne River during dry years. This would make it easier to supply the Bay Area during dry years from Don Pedro Reservoir and the Mountain Tunnel.

Null did not make an estimate of construction costs, but her study indicated that the major costs would be lost power (see energy discussion later in this report) and water treatment (see water quality discussion). There would also be additional costs: the cost of a physical connection between Don Pedro Reservoir and the Foothill Tunnel, and the lost energy due to reduced releases of water through the Don Pedro and La Grange Powerhouses and to lost head (lower water level) at Don Pedro Reservoir, which results in reduced power generation.

Option 2

Storage at Calaveras Reservoir; San Joaquin Pipeline Number 4

Calaveras Reservoir is on a tributary of Alameda Creek in southern Alameda County. (See Figure 2.) It was built in 1918 by the Spring Valley Water Company as a means of developing water supply for the San Francisco municipal water system. The dam is no longer considered safe. The Department of Water Resources has ordered that the dam be kept only 30 percent full, since there is a danger that it could collapse, especially in an earthquake.

In its Capital Improvement Program, San Francisco proposes to replace this dam with a much larger dam in order to increase the reservoir's capacity from 97,000 acre-feet to as much as 600,000 acre-feet. Recently, San Francisco has suggested that the maximum size of the reservoir would be 400,000 acre-feet, which removes the need for expensive wing dams across an earthquake fault. This enlargement of the reservoir would allow the city to divert up to an additional 300,000 acre-feet from the Tuolumne River annually, allowing for increased population growth in its South Bay service area. The city estimates that a dam that would store 600,000 acre-feet would cost $150 million in 2003 dollars. This estimated cost includes the pumping plant to move Tuolumne River water into the reservoir. RESTORE HETCH HETCHY estimates the cost of the recommended 400,000-acre-foot dam and pump station at $110 million.

In the study described above by Environmental Defense[xliii], Schlumberger Water Services estimated the cost of the dam and pumping plant as being in the range of $113 million to $240 million. The

reservoir would also be an emergency source of water should the aqueduct from the Sierra be forced to shut down for an extended period.

To allow the filling of such a large reservoir with Tuolumne River water, San Francisco proposes to construct a fourth San Joaquin Valley pipeline — a $391 million project (in 2003 dollars) that would add capacity to carry high winter and spring flows so that the enlarged Calaveras Reservoir could be filled more quickly. The pipeline would have a capacity of up to 160 million gallons per day (mgd). This pipeline represents a 53 percent increase in capacity over the sum of the first three pipelines (300 mgd); together, the four would have a combined capacity of 460 mgd. Operated incorrectly, this project could cause devastating losses to fish, wildlife, and recreation by diverting flows from the already depleted Tuolumne River in seasons when they are badly needed for these instream uses in the 117 miles of the Tuolumne downstream of Hetch Hetchy Valley, as well as further downstream in the lower San Joaquin River. It is critical that any new capacity in the San Joaquin pipeline system be used only when all lower and middle Tuolumne River environmental and recreational needs are being met.

When Hetch Hetchy Reservoir is drained, it would still be possible to construct the fourth pipeline across the San Joaquin Valley, enlarge Calaveras Reservoir, and store surplus flows from the Tuolumne for use in the Bay Area to replace the dry-year water supply. It is also possible that an enlarged Calaveras Reservoir could be filled without building the fourth pipeline, especially if the water efficiency and reclamation alternatives described above were implemented, and 79 million gallon per day capacity remains in the existing three pipelines during the times when water is available from the Tuolumne. Under this scenario, supplemental water from other sources (the Delta, desalination) might be needed, depending on how much regional demand grows in the future.

Mitigation Several impacts would have to be considered before conservationists could support the reservoir and pipeline projects.

Mitigation for Calaveras Reservoir expansion

Impacts on the Alameda Creek system would have to be considered. Raising Calaveras Dam by up to 200 vertical feet would inundate up to 3,500 acres of riparian and hillside habitat. This damage to the landscape would have to be mitigated by acquiring and restoring degraded habitat elsewhere in the South Bay. Removing Hetch Hetchy Reservoir would return about 1,972 acres to park and wildlife habitat use which might be used for mitigation, but this location is far away from the Alameda Creek watershed. Another possible mitigation would be to reduce grazing on San Francisco and East Bay Regional Park District lands in the Alameda Creek watershed to avoid the harmful impacts that conservationists argue grazing has on habitat and water quality in the creek and its watershed.

Introduction of Tuolumne River water into the Alameda Creek system may have impacts on the native steelhead in the creek. Although salmon are now blocked by the Bay Area Rapid Transit (BART) crossing near the Bay, there is an ongoing effort to mitigate that barrier and reopen the creek to the migration of native anadromous fish. A substantial effort is underway to restore Alameda Creek steelhead, which have been listed as threatened by the National Marine Fisheries Service. Dams are being modified, flow regimes are being reconsidered, and habitat is being restored to bring these magnificent fish back to

their native habitat. One of the Capital Improvement Program (CIP) projects would bring water to part of Alameda Creek again.

The Alameda Creek Alliance says there are landlocked steelhead in Calaveras Reservoir. San Francisco Public Utilities Commission staff acknowledges only that there are rainbow trout in Calaveras Reservoir. Landlocked rainbow trout can become ocean-going steelhead under certain conditions. Recently, the National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NMFS) proposed listing all rainbow trout in Alameda Creek, including those behind San Antonio and Calaveras Reservoirs, as "threatened" under the endangered species act. NMFS believes, basing its view on genetic and other studies, that the trout are essentially landlocked steelhead and could interbreed with the existing steelhead population[xlv]. These are the only landlocked trout on the west coast listed as certainly related to steelhead. The proposed listing makes a higher level of mitigation for raising Calaveras Reservoir much more likely and indeed may preclude raising the dam at all.

Assuming these environmental problems can be overcome, storage of Tuolumne River water in an enlarged Calaveras Reservoir would have a major advantage. In case of an earthquake that damaged any of the inter-basin transfer facilities serving the Bay Area — pipeline to Marin County from the Russian River, East Bay Municipal Utility District's Mokelumne Aqueduct, Hetch Hetchy Aqueduct, State Water Project South Bay Aqueduct and North Bay Aqueduct, Central Valley Project San Felipe Project — having 400,000 acre-feet of water in storage in the Bay Area would make an emergency series of pipeline connections much easier, possibly providing water to all nine Bay Area counties. Temporary connections of this type were made during the 1977 drought. The Metropolitan Water District of Southern California followed this reliability strategy by building Diamond Valley Reservoir in Southern California.

Water from Calaveras Reservoir is filtered, so the existing filtration plant would have to be enlarged to handle the increased volume. Enlargement of the Sunol Valley Water Treatment Plant to a capacity of 240 million gallons per day is included in San Francisco's Capital Improvement Program (CIP) at an estimated construction cost of $95 million.

If Tuolumne water is to be filtered at an expanded Sunol Valley Water Treatment Plant, then water from the Sierra would have to be pumped into the aqueducts (instead of the current gravity system), since treatment at Sunol would result in a break in pressure. This means that it may be necessary to include the cost of a pumping plant in the financing of this plan, or that filtration could be done near Moccasin Powerhouse before water enters the Foothill Tunnel by gravity.

Increasing the size of Calaveras Reservoir to 600,000 acre-feet is an approved part of the CIP, so no new financing would be required.

Mitigation for fourth pipeline

The source of the water for the fourth pipeline is critical. Ideally, the water would be pumped from Don Pedro Reservoir directly into the Foothill Tunnel that runs beneath Don Pedro at times when Don Pedro Reservoir is releasing water, primarily in the fall and winter. San

Francisco has up to 740,000 acre-feet of exchange water storage space in Don Pedro, more than twice the volume of the storage behind O'Shaughnessy Dam. [xlvi] San Francisco would have to obtain the right to pump this water from Don Pedro. Pumping would have to be done within the lower Tuolumne flow regime approved by the Federal Energy Regulatory Commission, to avoid any negative impacts on downstream fisheries. Again, no reductions in the flow of the Tuolumne for fishery purposes should be allowed. An additional constraint may be that current fish releases may not be high enough to provide sufficient protection for steelhead.

Before conservationists could support construction of a fourth pipeline, a thorough analysis would have to be undertaken by a neutral party to demonstrate that the pipeline would serve only to assure the reliability of the water supply and to assist in the use of an enlarged Calaveras Reservoir to replace the Hetch Hetchy Reservoir supply. Conservationists would not support a fourth pipeline if it were used to create new water supplies that would facilitate growth in the South Bay. San Francisco would have to provide assurances to that effect.

The estimated capacity of the Coast Range Tunnel has recently been lowered from 400 mgd (619 cfs) to 350 mgd (542 cfs) by SFPUC and HHWP staff[xlvii]. Thus, Coast Range Tunnel becomes a bottleneck that is not addressed in the CIP or elsewhere. The original plan in 1927 was to bore a second Coast Range Tunnel parallel to the present one. Even if the fourth San Joaquin Pipeline (SJPL) were built, the Coast Range Tunnel bottleneck would reduce the amount that could be diverted through the four SJPL's to 350 mgd. According to Schlumberger Water Services (Environmental Defense report[xliii] Appendix A, pages 30-34) the 4th pipeline might be able to increase pressure (head) on the coast range tunnel to allow a flow of 590 cubic feet per second (381 million gallons per day), alleviating the bottleneck. San Francisco (personal communication to Bob Hackamack, November, 2004) has confirmed that the San Joaquin pipelines and other components of the system can withstand the extra pressure.

As mentioned above, if the fourth San Joaquin Valley pipeline is built, it is critical that it have no negative impact on environmental and recreational flows in the Tuolumne River and that it be used to fill an expanded Calaveras Reservoir, which would provide replacement storage for water now kept in Hetch Hetchy Reservoir.

The three existing pipelines have a capacity of 300 million gallons per day. Today about 221 million gallons per day (mgd) are transmitted through the pipelines, and use is growing at about 0.5 percent per year. Since the water is diverted from the river at Hetch Hetchy Reservoir, the river is deprived of the water downstream. Reductions in the flow of the lower river affects salmon, steelhead trout, resident trout, other fish, river recreation, and aesthetics. Flows in the two whitewater sections are reduced. (The sections run from the confluence of Cherry Creek and the Tuolumne to Lumsden Campground, and from Lumsden Campground to Don Pedro Reservoir, a total of more than 23 miles.). At times, flows in the entire 52 miles of the lower Tuolumne, from La Grange Dam to the San Joaquin River, are also reduced. (If full capacity of the 4th San Joaquin pipeline were fully used for diversion, in years when runoff drops below 90 percent of average, some river uses or users may have to start taking shortages. See Table 1, Footnote 5.)

Operating the existing 3 pipelines to their capacity — thus increasing somewhat the amount of the river's flow diverted at Hetch Hetchy — would be detrimental to all these instream uses, but greatly increasing the diversions at Hetch Hetchy by adding the fourth pipeline would dramatically worsen the problem. Therefore, an ironclad guarantee must be provided by the city that the new diversions would occur only after the removal of Hetch Hetchy Reservoir, and that the increased diversions would take place only if the entire year's fishery and recreation flows were assured all the way to the confluence of the San Joaquin River.

Several critical flow criteria must be developed before additional diversions are allowed into a fourth pipeline.

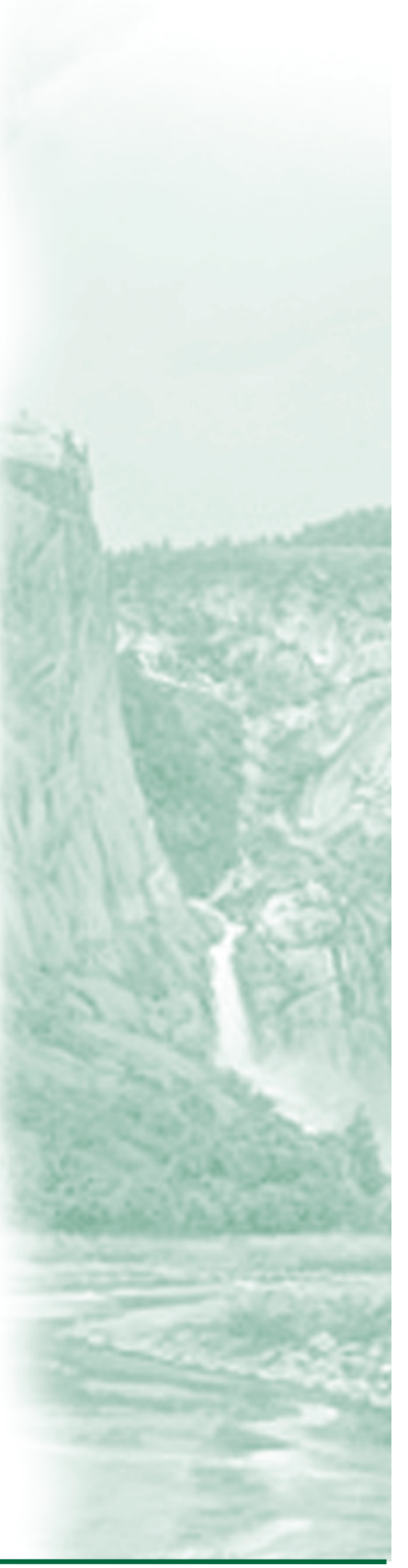
1. If diversions into the Canyon Tunnel are continued after Hetch Hetchy Reservoir is gone, minimal required flows must be increased in the Tuolumne between Hetch Hetchy and Early Intake Reservoir. These flows will be primarily for fish, but may also serve recreation (whitewater boating).
2. There must be a minimal flow of 1,200 cfs at the confluence of Cherry Creek no less than six hours a day from May 21 at least until the Sunday after Labor Day, except in the driest of years.
3. Minimum fish flows established by the California Department of Fish and Game and U.S. Fish and Wildlife Service must be met below Early Intake Reservoir and in Cherry and Eleanor Creeks.
4. The flows below La Grange Dam must not be reduced below those that will be negotiated in the relicensing of Don Pedro Reservoir, after that license in reopened for review. It is possible that new, higher flows will be established for steelhead and/or to maintain temperature, and if so, those must be met as well.
5. Only the additional amount of water needed to replace lost Hetch Hetchy storage may be diverted through the pipelines to be stored in enlarged Calaveras Reservoir.

Option 3

Enlarge Don Pedro To Hold More Water

The entire capacity of Hetch Hetchy Reservoir could be moved to Don Pedro Reservoir by raising Don Pedro Dam by less than 21 feet[xlix]. Restore Hetch Hetchy has found data suggesting the rise might be closer to 26 feet. This includes the 30,000 acre-feet of incidental flood control space that occurs at times at Hetch Hetchy Reservoir. No land acquisition would be necessary, since there are no private lands within 100 feet of the reservoir. Apparently wing dams would not be necessary, nor would it be necessary to raise bridges. Power generation at Don Pedro would be increased by storing additional water in this enlarged reservoir. The principal advantage of implementing this option is that the San Francisco service area would still receive Tuolumne River water of very high quality.

Raising the level of Don Pedro Reservoir would inundate about seven-tenths of a mile of the Wild and Scenic Tuolumne River. This loss could be partially mitigated by the required river releases discussed in the water section, above. Other mitigation would also be necessary. Of course, restoring the Tuolumne River in Hetch Hetchy Valley would restore an 8 mile stretch of river that would be added to the Wild and Scenic River System.



All of the Tuolumne water diverted to San Francisco from Don Pedro Reservoir would have to be filtered. Even after filtration, there would be a small increase in total dissolved solids (TDS) in San Francisco's water supply, since the water in Don Pedro is very slightly higher in TDS than Hetch Hetchy water. San Francisco adds lime to the aqueduct water to prevent leaching of minerals from the concrete in the San Joaquin pipelines that substantially increase the total dissolved solids of the water supply. Water San Francisco now uses from local Bay Area sources such as Calaveras and Crystal Springs Reservoirs is much higher in TDS, and even that water easily meets EPA drinking water standards.

The cost of enlarging Don Pedro Reservoir is estimated to be $234 million. This estimate is derived from San Francisco's estimated cost of adding 570,000 acre-feet of storage at Don Pedro in 1967, which was $52 million. Thus the 1967 cost to add 360,000 acre-feet of storage would be $33 million. To develop present day cost, RESTORE HETCH HETCHY used the Engineering News Record construction cost index to update the cost to 2004 dollars, and then multiplied the result by 1.2 to take into account such factors as deconstruction of the roadway atop the dam, taking the top part of the dam apart, knocking part of the spillway structure apart, adding extra wing dams, changing recreation boat launch ramps, and protecting the powerhouse at the base of dam. This estimate is probably high, since wing dams are evidently not needed.

If the dam were raised only 10 feet, in conjunction with other water supply options, only the spillway would have to be raised, making the cost of the raise far lower.

From San Francisco's point of view, an advantage of raising the height of Don Pedro Dam is that it would allow water filtration at Moccasin (or at Brown Adit where the Foothill Tunnel crosses under Don Pedro), and it would help the city meet its obligations under the Raker Act. Raising the height of the dam would also enlarge the water bank that the city needs for drought, and it would allow some water to be transferred directly from Don Pedro into the Foothill Tunnel.

Raising Don Pedro would provide additional "head" (elevation of water) for the powerhouse at the Dam, increasing power generation.

Option 4

Water Service From The Delta

More than 20 million Californians drink water from the Sacramento and San Joaquin Rivers and the Delta. There are many problems associated with the Delta water supply, including levee stability, organic and other compounds found in the water, complex fishery and recreation issues, and flood control. The state and federal governments have devoted billions of dollars to solving these problems. Together, they have created CALFED, a consortium of state and federal agencies, to oversee these solutions. The state has created the Bay Delta Authority as the overall CALFED program manager and has invited the federal government to participate. A public advisory committee to the Authority is also in place.

Although millions of people in Bay Area counties such as Napa, Solano, Contra Costa, Alameda, and Santa Clara rely on Delta water for

all domestic, industrial, and agricultural purposes, and even though San Francisco itself used Delta water filtered at its Sunol Valley Water Treatment Plant during the 1977 drought, San Francisco has resisted using Delta water ever again. The Delta is generally a reliable source of supply, since it collects water from the Sacramento and San Joaquin Rivers, whose combined watersheds include 41,000 square miles of the Cascades, Sierra, Coast Range, and Central Valley[li].

Another way of assuring a reliable water supply for the San Francisco service area would be to participate in one or more of several new water supply projects being proposed in the Bay Area. The Contra Costa Water District is proposing to enlarge Los Vaqueros Reservoir. San Francisco and its water customers could purchase space in the enlarged reservoir and transmit water through the California Aqueduct directly into the San Francisco Aqueduct system and/or to the city's South Bay customers through an enlarged South Bay Aqueduct. San Francisco would have to obtain a water right to this Delta water, and the water would have to be filtered. The State Water Project has a series of priorities for the use of the California Aqueduct, but they allow for the transmission of water of this type.

San Francisco could probably take credit for the recapture of all water released to the Tuolumne for the purposes of mitigation and increasing flood storage capacity. San Francisco has many water rights where the Tuolumne reaches the elevation of 2,200 feet above sea level (at the mouth of Cherry Creek). This water could be captured at the State Water Project Delta Pumping Plant and pumped into the California Aqueduct for transmission to the San Francisco system as described above. There would be pumping costs, but adding this supply would greatly increase the reliability of San Francisco's water supply.

Assuming pumping water into Canyon tunnel below Hetch Hetchy Valley, and into Mountain Tunnel from Cherry Creek, San Francisco would only have to use water from the Delta to fill in missing water supplies in about one year out of ten.

Option 5

Using Hetch Hetchy Groundwater (Minor Water Supply Benefit)

Although it appears that no one has measured the storage capacity of the Hetch Hetchy Valley groundwater basin, it would be possible to install a set of wells and buried pipelines that could be activated during an extreme drought. The cost-effectiveness of this plan would be determined based on a study of the basin's groundwater storage capacity. Up to three acre-feet per day (about 1,000 acre-feet per year) are extracted continuously from wells in Yosemite Valley[lii], and a somewhat smaller amount could probably be extracted from the groundwater table in Hetch Hetchy Valley. Three acre-feet per day amount to an additional flow of 1.5 cfs, which would allow the generation of additional power at times when the river's natural flow does not fill the Canyon Tunnel. In this scenario, only minimal facilities would be constructed above ground to avoid damaging the natural values of the valley. Even so, it is questionable whether the disruption of the restored valley would be worth the small additional yields of power and water.

Option 6

Raise or Re-operate Cherry Dam.

(Minor Water Supply Benefit)

Raising the height of Cherry Valley Dam to increase the storage capacity of Cherry Reservoir is a project that San Francisco has proposed in the past. In an average year, about 110,000 acre-feet of water spill over the Cherry and Eleanor Dams without running through Holm Powerhouse. Some of this water is also lost to power generation downstream at Don Pedro Dam at times when releases must be made from Don Pedro to maintain flood control capacity or because Don Pedro Reservoir is full.

Tuolumne River Trust

Raising Cherry Valley Dam and enlarging the reservoir would allow San Francisco to capture some of this spilled water and generate more power. Analysis indicates that increasing storage at Cherry Reservoir by 11,600 acre-feet would generate an additional 24 million kilowatt-hours of energy and reduce spills of "surplus water" by 3,000 acre-feet per year. Increasing storage by 105,000 acre-feet would increase generation by 148 million kilowatt-hours annually and reduce spills by about 100,000 acre-feet per year. Raising Cherry Dam would increase capacity by roughly 1700 acre-feet per foot of rise.

The land upstream from the current reservoir to the existing wilderness boundary has been proposed as the "Night Potential Wilderness." An enlarged reservoir of any size would inundate some of this proposed wilderness. If the dam were raised more than 100 feet, the enlarged reservoir's high-water mark could intrude a few hundred yards into the Emigrant Wilderness.

Another way to make Cherry Reservoir more effective would be to install larger pumps at the station that pumps water from Eleanor Reservoir to Cherry Reservoir. The pump station is located at the Cherry Reservoir end of the tunnel from Eleanor to Cherry Reservoir. Currently, ten pumps (each capable of pumping 35 cfs) lift water into Cherry Reservoir. Increasing the size or number of the pumps may be cost-effective. For each kilowatt-hour of power used to pump water from Eleanor Reservoir into Cherry Reservoir, roughly 20 kilowatt-hours could be generated at Holm Powerhouse downstream from Cherry Reservoir. This proposal would help reduce the power lost due to the removal of Hetch Hetchy Reservoir. There would probably be no significant water benefits.

Option 7

Water Sales from the Modesto and Turlock Irrigation Districts

The Modesto Irrigation District currently sells domestic water to the City of Modesto and may sell more in the future. There is no reason why similar sales to San Francisco could not also be implemented. Of course all downstream flow requirements in the Tuolumne below La Grange Dam would have to be met, including possible additional flows in the future for steelhead and

salmon. The sale price of the water should include a surcharge for power generation foregone at Don Pedro and La Grange Dams, since the water would be delivered from Don Pedro Reservoir and would bypass these generating facilities. Amendment of the Raker Act may be required, as would permission from the State Water Resources Control Board.

Such water sales are not unprecedented. In 2001 the San Joaquin River Group Authority proposed a 12-year transfer of 110,000 acre-feet to improve San Joaquin River water quality. The San Joaquin River Group Authority includes the Merced, Modesto, South San Joaquin, and Oakdale Irrigation Districts, the San Joaquin River Exchange Contractors, and the Friant Water Users Association.[liii]

Option 8

Desalination

San Francisco, the Marin Municipal Water District, and other Bay Area water agencies are considering the possibility of constructing ocean or bay desalination facilities. The costs of sea water desalting have declined considerably over the past 10 years, and a major new plant has been built in Tampa Bay. Impacts on marine life must be carefully considered and avoided, but obviously desalting can easily supply San Francisco and all its customers due to their proximity to the Bay and Pacific Ocean.

Option 9

Conjunctive Use of Groundwater on the Peninsula

San Francisco is considering storing water in the west side groundwater basin, which underlies the city and part of the peninsula south of the city limits. According to a 2004 report to San Francisco by Luhdorff and Scalmanini Consulting Engineers, this basin can hold up to 75,000 acre-feet, and water could be stored there for use in dry years when less water is available from the Sierra.

TUOLUMNE COUNTY: NOT FORGOTTEN

The Groveland Community Services District gets its water from the Mountain Tunnel and pays San Francisco for it, plus a surcharge. Since this proposal puts natural flow from Hetch Hetchy Valley plus water from Holm Powerhouse into the Mountain Tunnel, there will always be enough water for Groveland in the tunnel, except for infrequent tunnel maintenance, such as presently occurs. Filtration should be provided for this water supply, as well as the supplies to the communities of Early Intake and Moccasin.

CONCLUSIONS

There are more than ample ways of meeting the water needs of San Francisco and its customers on the Peninsula and in the South Bay if Hetch Hetchy Reservoir is drained. Even if it is determined that additional water is needed to serve a growing population in the South Bay service area, there is still plenty of water available.