

2004-2005 MARIN COUNTY CIVIL GRAND JURY

Water, Water Anywhere? A Review of Marin's Water Resources



Lake Nicasio in Drought, 1991

Date of Report: April 27, 2005

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Water, Water Anywhere? A Review of Marin's Water Resources

SUMMARY

The Grand Jury undertook an analysis of current and future supplies of water needed for Marin County. It was determined that supply and demand are balanced under normal year run-off conditions. However, the situation in central and southern Marin, the region serviced by the Marin Municipal Water District (MMWD), constitutes a serious risk during times of drought. MMWD estimates that, in the event of two consecutive dry winters (50% of average rainfall), a shortfall of about 3,000 acre feet (AF) will occur, even with mandated cutbacks of up to 25%. (For this estimate, MMWD considered the recurrence of a drought similar to that of 1976-77 and then factored in a reduction in demand through rationing and conservation.) By 2015, this shortfall is expected to grow to approximately 7,000 AF.

Therefore, MMWD has decided that additional sources of water are needed to minimize the risks that accompany droughts. The Grand Jury agrees. MMWD has explored many options, but only two appeared viable and significant: desalination of Bay water and increased imports of water from Sonoma, commonly referred to as Russian River water, via an enhanced pipeline. The latter option is less expensive than desalination, but it is projected that additional supplies via a pipeline would not be available for 10 to 15 years, whereas a new desalination plant could be operating in five years. MMWD has identified other advantages of desalination, including the fact that the water would be under complete MMWD control.

The Grand Jury recommends that conservation of an additional 10% be implemented even during normal times. The Grand Jury recommends that MMWD fully inform the public of its plans for supplying water during a drought and seek approval of its choice via the ballot box. Because MMWD is legally required to release water from its reservoirs to sustain Coho salmon and steelhead trout during droughts, the Grand Jury recommends that legal requirements for dam releases to sustain endangered fish during droughts be renegotiated to increase water availability for public consumption.

BACKGROUND

All water agencies have the responsibility to provide clean, inexpensive water to meet the needs of their constituents. Marin County experienced three droughts in the last century. The drought of 1976-77 was the most severe in the last 30 years and highlighted the lack of reliable alternatives for the County to procure water in times of serious shortage.

MMWD, which has the responsibility for operations and planning at the local level, is undertaking an in-depth cost and reliability analysis of alternative water sources that include desalination, increased Sonoma County Water Agency (SCWA) imports via a pipeline, and groundwater.

In times of drought, northern Marin, serviced by the North Marin Water District (NMWD), is in a better position than southern Marin. Eighty percent of NMWD's water comes from the Sonoma County Water Agency, i.e., outside of the county, and NMWD arranged to be a prime contractor with a first cut at SCWA water flowing through Novato. MMWD, on the other hand, is only a

customer and does not have the same guarantees of water being available that contractors have. NMWD serves about 57,000 people using about 10,000 AF annually, compared to MMWD, which serves about 186,000 people using some 32,000 AF annually. (For units of measurement used throughout this report, please see Water Measurements box, below.) The coastal water districts, Muir Beach, Stinson Beach, Bolinas, and Inverness, rely on groundwater and stream-fed sources that appear to be adequate for current and projected needs, provided their customers reduce water usage in times of drought. Thus, in all of Marin County, central and southern Marin, which are serviced by the MMWD, are more at risk.

The units of water measurement shown in the box below will help the reader in understanding the following discussion.

WATER MEASUREMENTS

Our water bills are calculated in units of 100 cubic feet (CCF).

- One CCF equals 748 gallons.

Storage tank sizes are measured in millions of gallons (MG) and production and treatment facilities in millions of gallons per day (MGD).

- 326,000 gallons equals one acre-foot (AF), the quantity needed to cover one acre one foot deep.
- One AF will supply three households for one year.

Large scale usage is measured in acre-feet per year (AFY).

- 1000AFY is roughly equal to 1MGD.
- A 5MGD desalination plant will produce about 5000 AFY.

METHODOLOGY

Interviews and contacts were held with current and past Board Members and staff of the Marin Municipal Water District, the North Marin Water District, and the coastal water districts of Marin County, as well as other interested and informed parties in both Marin and Sonoma counties.

The Grand Jury:

- Read and analyzed many reports dealing with water management, water needs, and water usage in Marin
- Investigated and analyzed the potential use of all sources of water to provide adequate water under drought conditions
- Analyzed the costs of the various options to provide water

DISCUSSION

Where Does the Marin Municipal Water District Get Its Water Today?

MMWD's supply of 32,000 AF per year (AFY) consists of the following:

- Seven storage reservoirs with a total capacity of 79,566 acre feet (25.9 billion gallons) which provide 72%, or about 23,000 AFY, of water used, at a cost of about \$280/AF
- A pipeline from the North Marin Water District for delivery of Sonoma County Water Agency water, which provides 8,000 AFY, i.e., 26% of the total, at a cost of about \$500/AF
- Recycled water, primarily from the Las Gallinas water recycling plant, which provides only 2% of the total

Will Central and Southern Marin Have Enough Water for the Future?

For MMWD's service area the Association of Bay Area Governments (ABAG) projects a small population increase from the 184,818 persons in 2000 to 198,846 by 2020. Current systems and agreements for shipments of water meet all normal year demands because winter/spring rains fill reservoirs to provide enough water throughout a normal dry summer. In addition, MMWD has built a reserve sufficient to serve customers even if there is a dry winter followed by a dry spring. This system has served the central and southern Marin community successfully for the last century but was most recently stressed during the droughts in 1976-77 and the late 1980's indicated in Figure 1.

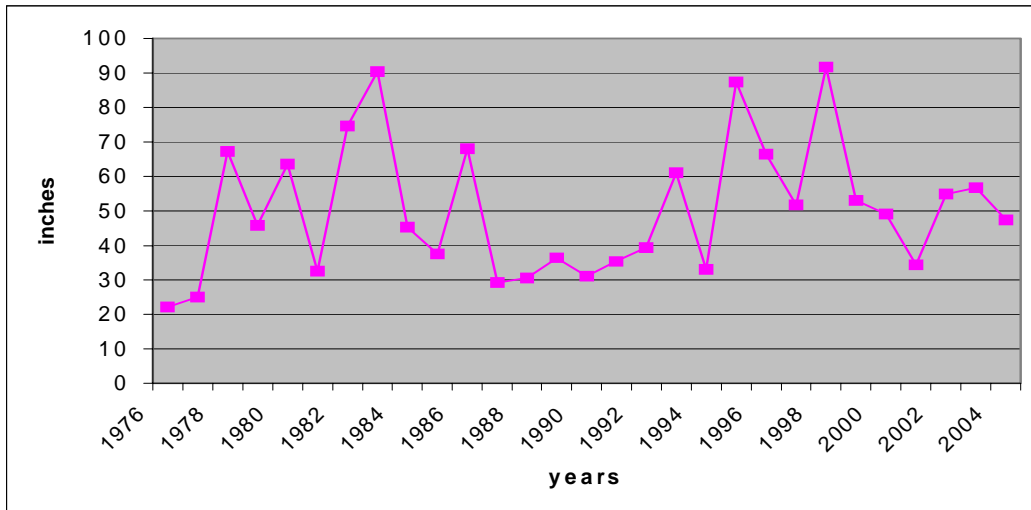


Figure 1 Rainfall at Lake Lagunitas 1976-2004

Several important factors have changed since the 1976-77 drought. Reservoir capacity has increased from about 53,000 to 80,000 AF, and the importation of SCWA water has grown to 8,000 acre feet per year (AFY). These changes, if taken only by themselves, would mitigate the

effects of a drought, making a 1976-77 style drought less onerous than it was then. Recently, actual reservoir storage capacity has been questioned. Water experts indicate that up to 15% of what is listed as reservoir capacity actually consists of silt and mud that cannot be tapped easily. In addition, by the time a drought is recognized, much of reservoir capacity already will have been used.

Furthermore, even in droughts, legally required releases of water from dams to sustain endangered fish in Lagunitas and Walker Creeks have first priority on reservoir water. These releases average about 9,000 AFY, and the releases needed to maintain required flows may actually increase during droughts. For example, Soulajule reservoir, which is used only in emergencies, had less than half of its capacity available when the last drought was first recognized, the rest having been released to Walker Creek to support salmon spawning runs. During droughts this “fish flow” would roughly cancel the gains from the changes noted above, making a 1976-77 style drought as bad as before. The Grand Jury believes that if the required stream releases were successfully renegotiated, more water would be available for needed human use.

How Much Is Enough?

Water agencies plan for a worst-case scenario based on recent experience. MMWD has calculated the available supply as being about 30,000 AFY. In general practice, current supply levels accumulated through a normal winter and spring carry us through a normal dry summer. If a drought then occurs in the following winter and spring, it would force the use of reserves and conservation efforts beginning with 10% minimum cutbacks. If the drought continued for a second winter and spring, emergency measures would be instituted with 25% minimum cutbacks; but even then, there would not be enough water to last through the following summer and fall. This second year of drought would be expected to deplete all reservoir capacity, and even with the conservation efforts listed above, MMWD would be at least 3,200 AFY short.

By the year 2015, demand is predicted to increase by another 1,650 AFY. When this is coupled with the loss of 2,300 AFY in pipeline deliveries projected by that time (see below), two years of drought is expected to result in a total projected deficit of 7,060 AFY.¹ This scenario approximates the County’s actual experience in the drought of 1976-77 adjusted to today’s circumstances. The impact of such a deficit is characterized by officials of MMWD as being “extremely severe.”

Can Local Ground Water Be Tapped To Augment Supplies?

Currently, development of increased access to ground water, with a hoped-for potential yield of 1,000 to 2,000 AFY, is under study by a consulting firm, GSi. Senior staff at MMWD, however, dispute the number of 1,000-2,000 AFY, believing it to be too optimistic.

Can Central and Southern Marin Get More of Its Water from Sonoma?

The question arises as to whether or not central and southern Marin could simply get more water from Sonoma County. The answer is no, because present facilities are limited. As described by

¹ “Desalination” presentation by MMWD

water experts, SCWA water, mainly from Lake Sonoma, is mostly available to Marin in the winter, when it's not needed, with little being available in the summer, when it is needed. At this time MMWD gets up to 26% of its water supply from Sonoma. Under a contract with SCWA, water flows from collectors on the Russian River near Guerneville through an SCWA pipeline to the Kastania Storage Tank in Petaluma. From there, it travels via an NMWD pipeline to an MMWD connection in Ignacio. Because the pipelines have a finite capacity and Sonoma County and north Marin water usage continues to increase as their populations grow, less water will be available for delivery to central and southern Marin. The 8,000 AFY being received now is estimated to shrink to 6,000 AFY by the year 2015. This is termed the "Projected Decay of Excess Delivery Capacity" in the NMWD system. In the summer, the pipeline that MMWD shares with NMWD puts out water at a rate faster than the water can be replenished. Some water officials think that the demand for water already exceeds what the pipeline can provide.

NMWD draws its SCWA water from the Kastania Storage Tank. During peak demand periods in summer, the storage level of Kastania falls below a critical 50%. Because of the decline in excess storage capacity, "the rate of storage depletion continues to increase each consecutive year."² It is forecast that by 2015, some 2,300 AFY of water will be lost to MMWD unless SCWA can physically increase its deliveries to Kastania. A voter approved bond issue in 1992 (Measure V) provided funds for a new pipeline to be built alongside the current one. Absent a drought-induced immediate need and with continuing anti-growth sentiment, that pipeline was never laid, and the funds for it remain available for other purposes. MMWD now calculates that pipeline enhancement and in-system distribution improvements adequate to provide an additional 5,000 AFY (at an estimated cost of \$1,020 to \$1,460 per AF) will cost a total of about \$70 million.³

For the last 12 years, MMWD has been monitoring both the decay of pipeline delivery capacity and the availability of SCWA supply, but no decision has been made on the proper timing for pipeline enhancement. Part of the reason is that some officials at MMWD worry about relying on the Sonoma County Water Agency for any long-term solution. They express concern with the agency's level of commitment to their non-county customers and contractors. (A Contractor, such as NMWD or Petaluma, is one of the original signatories to the SCWA Water Agreement Master Plan, with primary and equal rights of access. A Customer, such as MMWD, is a secondary beneficiary, receiving water only "as available.") They mention issues with reliability and follow-up. "There are real problems with sourcing through them." But foremost is their concern about giving up control to an outside agency (i.e., SCWA).

It should be noted that even in the best of circumstances, including full funding and permit approvals, an appropriate pipeline would take 10-12 years to complete.⁴

MMWD has various existing contracts with the Sonoma County Water Agency for supplemental water supplies:

- An Off-Peak Water Supply Agreement concluded in 1975 provides for the delivery of up to 4,300 AFY of SCWA water primarily during October through May (the rainy season when the water is usually not needed) of each year.

² SCWA Staff Report Nov.1,2004.

³MMWD Long Range Financial Master Plan.

⁴ Marin Municipal Water District Board Member interview

- An “As-Available” Water Supply Agreement signed in 1991 and amended in 1996, making 5,000 AFY available during May through October (the usual dry season when water is needed) on a “firm” basis with an option on an additional 5,000 AFY from Lake Sonoma. (MMWD has until June 30, 2005 to make the additional 5,000 AFY “firm”.)

MMWD and SCWA are negotiating possible modifications to these current agreements such that MMWD would have until 2014 to decide whether or not to pay about \$6 million to obtain the rights to that additional 5,000 AFY of Lake Sonoma water. In exchange for the extension until 2014, MMWD would agree to pay a contemplated environmental surcharge, and fund a portion of SCWA’s planned system improvements. The price of this water would be capped at \$500 per acre-foot.⁵

Both of the existing contracts remain in effect until June 30, 2034, but are burdened with problems:

- In 1972, MMWD declined to become a “prime contractor” with water rights equal to those of other users of SCWA water. This puts them at the end of the line for receiving water that might be in short supply during a drought
- The future of Sonoma County water deliveries is clouded by the current “Impairment” regime. In 1992, the SCWA started to prepare an Environmental Impact Report (EIR) for planned improvements to their water supply system to enable it to meet defined future needs of its contractors, e.g. NMWD and customers, such as MMWD. In 1998, the EIR was certified, and the system’s enhancement plan approved. Litigation ensued, however, and in May 2003, in *Friends of the Eel River v. Sonoma County Water Agency*, the EIR was found to be deficient. In December 2003, the Sonoma County Superior Court directed SCWA to rescind approval of the planned improvements, and to prepare a supplemental EIR addressing the environmental concerns at issue, e.g., Russian River flow volumes and Eel River diversions. An entirely new EIR was considered necessary to reflect changed demand based on current general plans and the results of an exhaustive biological study of the Russian River. “In some cases what was a future need is now a current need.”⁶ New EIR certification and approval of the system enhancement plan may come before the SCWA as early as summer 2007. Until SCWA can complete its system improvements, it will not necessarily be able to fulfill its contractual obligations for water supplies for its contractors and customers and is therefore considered to be “impaired”.⁷

Wasn’t There a Pipeline from the East Bay Municipal Utility District (EBMUD) over the Richmond – San Rafael Bridge?

During the severe 1976-77 drought, an emergency measure allowed the delivery of EBMUD water over the Richmond-San Rafael Bridge. A temporary pipeline was rapidly put in place. The pipeline has since been removed, and EBMUD has advised MMWD that, because they need the

⁵ .SCWA Staff Report Nov.1,2004.

⁶ Ibid.

⁷ Ibid

water for themselves, such deliveries will not be made in the future. Twenty-eight years after the last receipt of water from EBMUD, no reliable alternative emergency supply has been identified.

Can Users Conserve Enough Water To Carry Us through Another Drought?

The drought scenarios in place assume that major conservation efforts will occur as soon as a drought is declared. In fact, significant conservation efforts are already taking place and are being encouraged through tiered pricing, rebates, consultations, education, and monitoring. For example, many residences already use low-flow toilets, and MMWD is seeking further reductions in landscape irrigation. However, by the time a drought is declared at the end of the first dry year, MMWD would already have depleted half of its reservoir storage. Ongoing conservation of about 10% of usage before the first dry year could allow MMWD to retain enough water in its reservoirs to lessen the impact of a second year of drought.

MMWD engineers, however, are concerned that “demand hardening” will occur; i.e., not much more “conserving” can be demanded from the consumer. Considering the growth in demand for water over the last three decades, a two-year drought of the magnitude of 1976-77 would require extreme efforts at additional conservation.

Consequently, MMWD has adopted the following approach to dealing with drought conditions:

- Voluntary rationing with a target of 10% reduction in water use reached when reservoir storage falls below 50,000 AF on April 1 or
- Mandatory 25% rationing when April 1 reservoir storage falls below 40,000 AF.
- Incremental forced rationing up to 50% levels and higher are planned as supplies tighten, with residential services being given allotments based on the number of people per household.⁸
- Exceeding the residential allotment two times can result in the forced installation of a flow restrictor and a 20% surcharge.

Can the Recycling Effort Be Expanded?

Starting with a pilot plant during the drought of 1976-77, MMWD was a pioneer in water recycling. The present Las Gallinas Water Recycling Plant annually produces 700 AF for specific use in landscape irrigation, a car wash, and toilet flushing at the county jail and nearby office buildings.⁹ Possible expansion of the Las Gallinas plant depends upon the size and type of future development at the nearby St.Vincent/Silveira properties. Estimated costs for this expanded production average from \$2,660/AF to \$3,220/AF.

MMWD studied expansion of the recycling effort further south at the Central Marin Sanitary Agency (CMSA) sewage plant in southeast San Rafael. About 900 AFY of potential recycled water use had been identified in the service area. Unfortunately, further study revealed that too much salt water was intruding into the CMSA sewage collection system to make usable recycled

⁸ MMWD 2000 Urban Water Management Plan

⁹ Ibid

water economically feasible.¹⁰ A 2004 study of potential smaller satellite plants identified 3 sites with a total of 280 AFY at costs per acre foot ranging from \$3,420 to \$6,470. Water recycling efforts, though successful, realistically have already reached their maximum. With current technology, cost estimates for increased recycled water production make it the most expensive of the options considered, as indicated in Table 1.

Table 1 Water Supply Costs

Source	Cost
Reservoir	\$280/AF
SCWA imports	\$500/AF
Increased SCWA imports through enhanced pipeline	\$1,020/AF – \$1,460/AF
Desalinated	\$1,500/AF – \$1,700/AF
Expanded recycled	\$2,660/AF – \$3,220/AF

Is Desalination a Viable Alternative?

MMWD considers desalination a strong option for meeting Marin’s water needs in the event of a two-year drought and is moving forward with a pilot desalination plant using continuous seawater reverse osmosis (RO) (for a description of the process, please see Appendix). This operation, located in San Rafael near the Marin Rod and Gun Club, is scheduled to begin in May 2005 and gather data over a nine month period. The program’s goals are to:

- Demonstrate the reliability and efficacy of the process using Bay water
- Determine the best pretreatment process to ensure landfill acceptability of the resulting sludge
- Develop design criteria and operating parameters for a full-scale facility
- Validate cost assumptions
- Conduct a public outreach program

A desalination plant capable of handling 5 million gallons per day (MGD), about 5,000 AFY, and able to be expanded to 10 MGD, about 10,000 AFY, is expected to cost about \$95 million and take about 5 years to construct. If an expanded plant operated at 10 MGD, the cost of water is projected to be about \$1,500 per AF. In normal years, the operating rate of the unexpanded plant would be 1 MGD for nine months and 4 to 5 MGD for the three summer months. In a drought, it would run at a maximum rate of 5 MGD for as long as required. Water cost at 5 MGD is estimated to be about \$1,700 per AF.

Although the process is not seen as harmful to the Bay, a full EIR will be required. Some in the environmental community prefer desalination over expanding SCWA pipeline service. The plant’s output of brine will be mixed with current output from the CMSA sewage treatment plant and be discharged in the center of the shipping channel through existing pipelines. Sludge

¹⁰ MMWD 2000 Urban Water Management Plan

resulting from pre-treatment will be shipped to the Redwood Landfill. Aspects of both these processes are being tested as part of the desalination pilot plant program.

Engineers indicate implementation of a full-scale desalination plant with this technology will be difficult. "It won't be very pretty, and it will cost a lot of money, and I sure don't want to be the first person on my block to give it a try, but we may be forced to do that. I don't look forward to being the first water district to use San Francisco Bay water as a source for a desalinating water plant. As the guinea pig, every regulatory agency is going to take a shot at us. They won't want to look as though they were asleep at the wheel when this came out. So it will take us longer and be more difficult for us to operate..."

On the other hand, the technology is being used or is under study in many places. In California desalination projects are under study by Oceanside-Carlsbad, Long Beach, West Basin MWD, City of Los Angeles, MWD Orange County and Port Hueneme. Plants constructed in Santa Barbara and Moro Bay are mothballed pending need. Feasibility studies are now underway in Texas for sites in Lower Rio Grande Valley-Brownsville, Corpus Christi and Freeport. Florida's installation on Tampa Bay suffered serious feedwater pretreatment problems and is not expected to resume operations until 2006. Successful international sites include Israel, Saudi Arabia, United Arab Emirates, Kuwait and Jordan. Specific criteria favoring desalination are seawater access and economical electric power.

How Would MMWD Finance It?

As previously noted, the bill for a full-scale desalination plant is sizable. Although MMWD currently owns land near the Bay that it could use, this new technology will still require significant investment. Current estimates for plant, distribution system, and additional operating costs, through 2014, total about \$211 million.¹¹ The agency has some \$20 million from a previous bond issue, plus additional cash reserves. Furthermore, the State has announced preliminary approval of a \$3 million grant toward MMWD's desalination project costs. Other grants from State and Federal sources may be forthcoming.

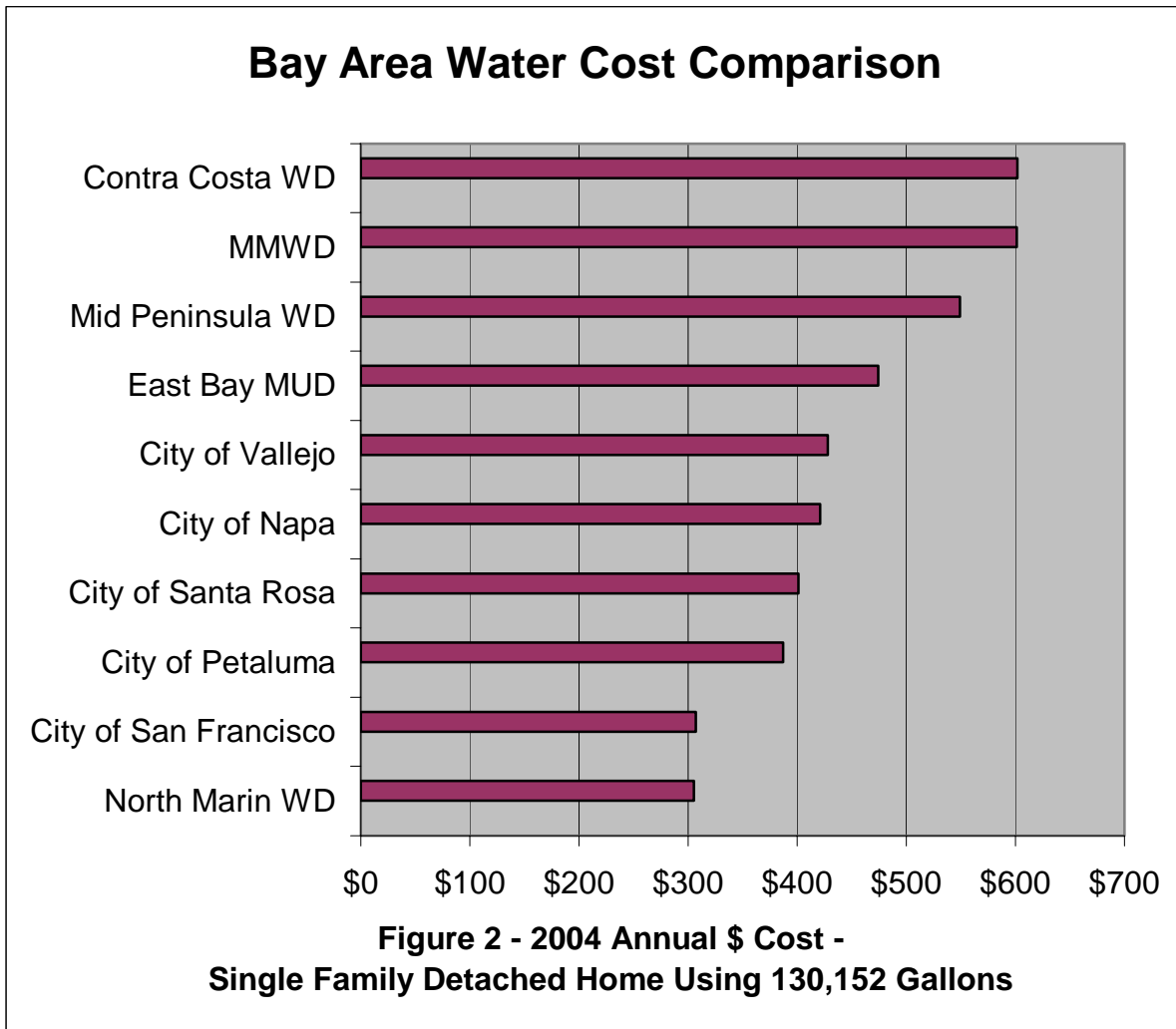
In the opinion of MMWD's General Counsel, the rest could come from a new bond measure passed by the voters or could be funded without going to the voters by using certificates of participation, grant anticipation notes, and other off-ballot financing arrangements that do not contravene the State Water Code.

How Much Will It Cost Consumers?

The cost estimates for both desalination and SCWA water are extremely high. By 2014, tier 1 rates/CCF are expected to increase from the present \$2.43 to \$4.21 with desalination and to \$3.79 with SCWA water.¹² Clearly, rates will have to increase well above the inflation rate. MMWD costs are already high in comparison to almost all other Bay Area suppliers as indicated in Figure 2, on the following page.

¹¹ MMWD Long Range Financial Master Plan

¹² Ibid



Are There Other Alternatives?

Geography limits MMWD's access to water. Only local reservoirs and the Russian River watershed to the immediate north are viable sources with adequate volume. Multiple options have been investigated over the years but have been rejected for environmental reasons, prohibitive costs, or safety concerns:

- Diverting Lower Lagunitas Creek
- Creating a Devil's Gulch Reservoir
- Tapping local floodwaters
- Raising Kent and Nicasio Lakes
- Damming San Antonio Creek

- Building a North Bay aqueduct for Delta water purchased from the State
- Using the Mokelumne Aqueduct (East Bay Municipal Utilities District)
- Using the Hetch-Hetchy Aqueduct (San Francisco)
- Expanding the treatment plant for reclaimed wastewater for reuse

Does the Public Have a Role to Play?

When asked if public awareness of the issues needs to improve, one senior official said, "Yes! This has to be ingrained in people's psyche – to use less water. We are living in a dry climate and we have to conserve. It doesn't rain in the growing season. Something has to happen to get people's attention. Reduce normal demand by 10% and that will buy us time."

Although a prolonged drought is relatively rare, its accompanying danger is very serious. So the question of going to the voters for funding desalination is a difficult one. As described by one water official, "You're torn between two things. Your fundamental responsibility is to guarantee a reliable, safe, affordable water supply for our customers, and on the other hand, you want to respect the will of the people. If the will of the people is that they don't want it, and yet all your experts say this is the only way to get it, do people have the right to vote themselves into danger? Water is a public safety issue, like the police department."

Nevertheless, the Grand Jury believes that Marin voters should be polled, and they need to be fully informed of the present water situation, because they will ultimately be paying for the solution through their water bills. MMWD, through its *marinwater.org* web site, has an excellent information medium in place. However, it is not being used to provide the hard information that an informed citizenry needs. As of late February 2005, publication of the board of directors' meeting minutes was four months late. Although numerous detailed studies, consultants' reports, and staff reports (which support meeting agenda items) are being produced, printed, and given limited distribution, they are not being posted to the web site. Because public opinion will play a large part in the ultimate solution to Marin's water problem, MMWD needs to properly inform and educate the public.

FINDINGS

- F1. The repeat of a drought of the severity of 1976-77, even under current drought response plans, would leave central and southern Marin at significant risk of having a severe water shortage.
- F2. Routine conservation programs have been effective in drought-free years, but an additional 10% reduction in normal usage is necessary to prepare for the occurrence of a possible drought.
- F3. Recycling is expensive and has limited potential.
- F4. Two strong, viable, though expensive, options exist for alleviating the effects of a drought: building a desalination plant or increasing Sonoma County Water Agency deliveries through a pipeline.

- F5. A decision to pursue either option can apparently be acted on without being put to a popular vote. An action plan from MMWD, with full public disclosure, is overdue.
- F6. Legally required dam releases to sustain endangered fish have first priority on reservoir water even in droughts.
- F7. North Marin Water District and the smaller coastal water districts appear to have adequate water supplies.

RECOMMENDATIONS

The Grand Jury recommends as follows:

- R1. The Marin Municipal Water District (MMWD) should take a stronger position on conservation ensuring a minimum reduction of 10% in normal base-level usage. Conservation measures should include educating the public in what it means to live in a dry summer climate.
- R2. MMWD should inform the public of its plans for supplying adequate water during a drought before committing to a solution. MMWD should publicize the directions chosen in terms of timing, costs, impacts on water rates and the degree of dependency on other agencies for the various options.
- R3. MMWD should put to a public vote any project of the magnitude of desalination and SCWA pipeline expansion.
- R4. MMWD should attempt to renegotiate required dam releases with the relevant Federal and State agencies to reduce legally required stream flow requirements during droughts.

REQUEST FOR RESPONSES

Pursuant to Penal code section 933.05, the grand jury requests responses as follows:

- Board of Directors, Marin Municipal Water District F1–F6, R1–R4.
- Marin County Board of Supervisors F5, R3.

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APPENDIX

THE MARIN DESALINATION PROCESS

The desalination process that MMWD will use is called Reverse Osmosis.

In this process, saltwater is forced through a very tight plastic membrane that allows water molecules to pass through while larger molecules do not. It is called “reverse” because, without the strong pressure, water would naturally flow in the opposite direction. The steps involved are:

- The saltwater is pretreated by filtration. This is a critically important step to remove particles that would otherwise plug the membranes. (This is the step that became a big problem in the Tampa Bay plant and caused major cost increases and delays.)
- The filtered water is then forced through the membranes.
- Two gallons of saltwater yield one gallon of potable water and one gallon of brine that has double the salt concentration of the feed.
- The potable water is given a post-treatment over limestone to improve taste and decrease corrosiveness.
- The brine is discharged into the Bay, preferably after mixing with sewage treatment effluent which has low salt content.
- Sludge from the pretreatment is taken to a landfill.

All the steps involved require the approval of regulators.



Lake Nicasio Spillway April 18, 2005