

# California Desalination Report with More than a Grain of Subjectivity



**Figure 1. Ongoing seawater desalination projects in California**

In June 2006, the Pacific Institute (PI) published a report entitled, *Desalination, With a Grain of Salt—A California Perspective*. Ignoring several decades of successful track record of desalination in over 120 countries worldwide and the recent groundbreaking advances in applied desalination research in California, the report presents an opinion that most of the ongoing seawater desalination initiatives in the State of California are premature. This opinion is not shared by the people of California, who in the November 2002 state election voted in support of *Proposition 50*, which endorses the development of an integrated water management plan for the Golden State in which desalination finds its rightful place, along with enhanced water reuse and conservation.

The report ignores the state government's recognition that reliance on existing fresh water resources, aggressive conservation and water reuse alone may not be adequate to meet long-term water demand and that the California Department of Water Resources (DWR) has charted a new course of exploration of seawater and brackish water desalination as an alternative reliable and drought-proof water supply addition to the state water portfolio.

The potential barriers associated

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with the use of seawater desalination presented in the report are: the growth inducement potential of the proposed desalination projects; the affordability of the desalinated water; the relatively higher energy use; the potential environmental impacts from the operation of the desalination plant intake and discharge; and public health concerns associated with the quality of desalinated water.

## **State of research**

Currently the DWR is administering a (US) \$50 million desalination grant program created to assist water utilities statewide in the implementation of brackish water and seawater desalination projects. The first round of this program was carried out in 2005 by awarding \$24.75 million to 24 different desalination projects.

The second round of the program awarded another \$21.5 million of grants to 23 projects in June 2006. The grand funding was allocated to feasibility studies; applied research, development and pilot testing activities; and to the implementation of demonstration and full-scale desalination projects. The funded projects (scheduled to be completed by 2009) are expected to provide practical solutions to key environmental, energy and cost challenges that the use of desalination may face in California.

## **Will desalination initiatives induce unplanned growth?**

California's desalination initiative is planned to yield over 20 new projects statewide which would supply up to 450 mgd of high-quality drinking water by year 2020. Locations of the key ongoing seawater desalination projects throughout the state are indicated in Figure 1.

Even if all of the proposed desalination projects are built at their maximum planned capacity, they would be adequate to only supply 1.1 percent of the total current state water demand of 40,000 mgd and approximately 5.6 percent of its urban water demand of 8,000 mgd. The PI report insinuates that this

volume of 'new' water is somehow going to spur significant population growth and would result in an unpredictably high burden on the state's electrical supply system and other resources. A look at the actual facts, however, reveals a very different story.

According to the 2005 California Water Plan, by year 2030 the state's population is projected to increase by 31.5 percent (from 36.5 million to 48 million), which averages approximately 1.26 percent per year (prorated to 12.6 percent by year 2015, when all proposed desalination projects are to be operational). It is obvious that even if the entire 5.6 percent increment of state urban water supply that would result from the implementation of all of the proposed desalination projects is applied towards the 12.6 percent of population growth planned to occur by year 2015, this supply increment would be sufficient to meet less than half of this planned growth. Therefore, the PI report's conclusion that the proposed desalination



**Figure 2. Carlsbad Seawater Desalination Project**

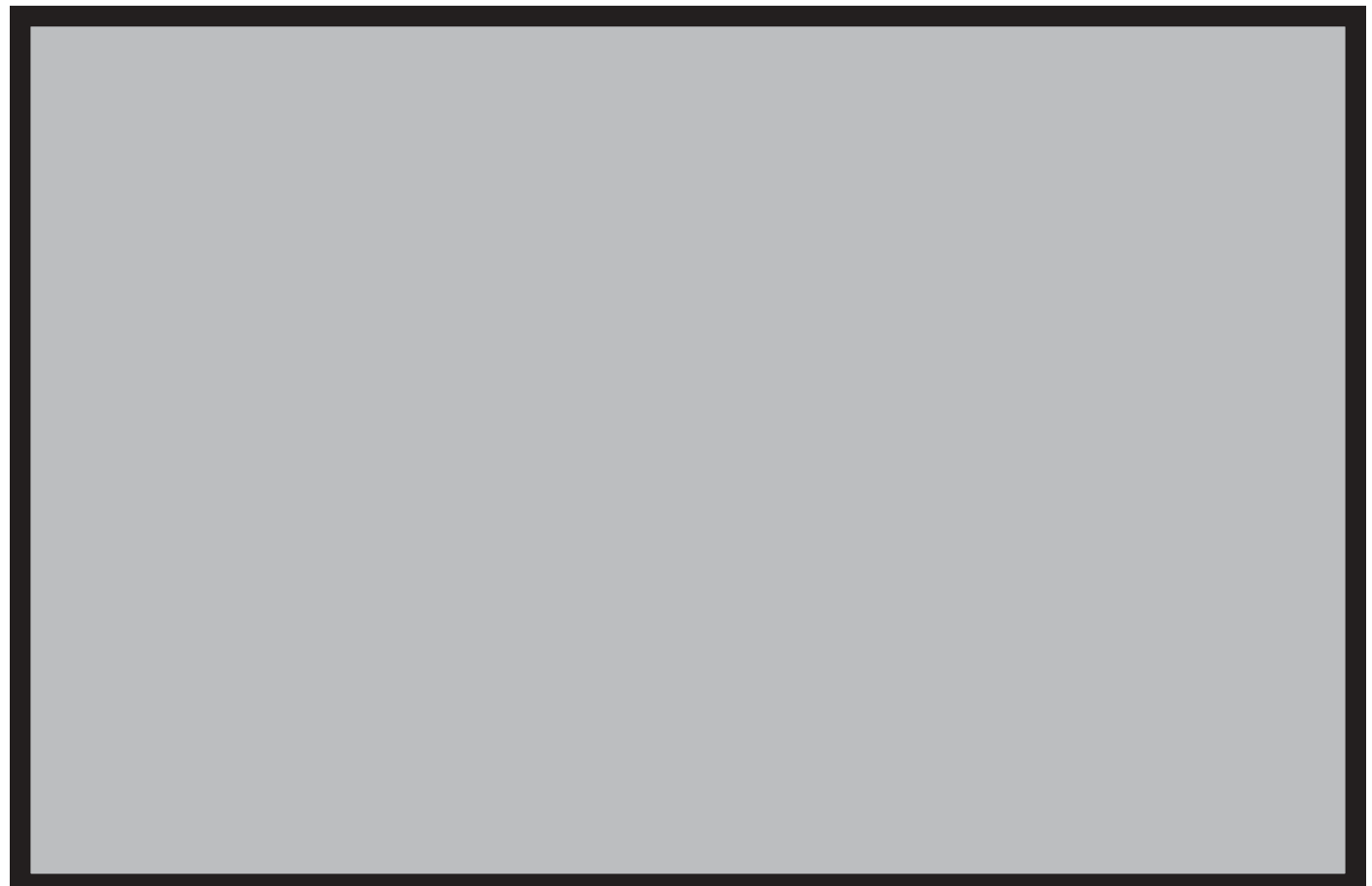
projects have significant potential to induce unforeseen and unplanned population growth in the state is unrealistic and also lacks common sense.

Review of the environmental impact reports (EIRs) which have already been prepared for a number of the proposed desalination projects clearly indicates that the main purpose of these projects is to reduce reliance on future increases to in-state or out-of-state water transfers which would be unsustainable in the long-term; to curtail further over-pump-

ing of already severely deteriorated groundwater aquifers; and to curtail existing water supply practices throughout the state that have significant environmental impact on fragile river ecosystems, rather than to accommodate new population growth in the respective project service areas.

For example, the EIR for the 50 mgd Carlsbad seawater desalination project, which was certified in early 2006, clearly states that this project is planned to replace the reliance of the City of

Carlsbad and a number of other neighboring utilities on water imported from the Sacramento-San Joaquin River Delta and the Colorado River because these sources are drought sensitive and have uncertain futures. Due to lack of local water resources (groundwater aquifers suitable for water supply and surface fresh water sources) the City of Carlsbad currently relies solely upon imported water for its water supply. This condition is shared by the majority of the communities in San Diego County where imported



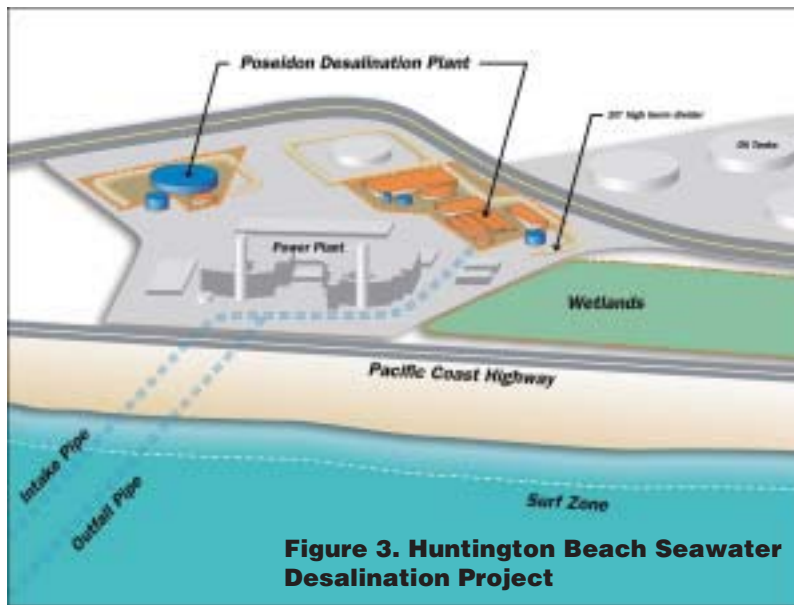
water makes up over 80 percent of the county's current water portfolio.

Similarly, the EIR for the 50 mgd Huntington Beach seawater desalination project certified in the spring of 2006, states that the main purpose of the project is to provide relief to the over-pumped coastal aquifers of Orange County and to reduce reliance of the county's water supply on imported water, rather than to accommodate new population growth. The desalinated water produced from the project

is planned to be introduced in the county's regional water distribution system and to be delivered to over two dozen municipalities and utilities.

The ongoing desalination initiatives in Northern California (see Figure 1) are also driven by pressing environmental concerns, water supply aquifer deterioration trends and by the need to secure long-term water supply reliability and sustainability.

For example, one of the largest sea-



**Figure 3. Huntington Beach Seawater Desalination Project**

water desalination projects currently under development in San Francisco County is proposed by Marin Municipal Water District. This project is targeted to produce between 10 mgd and 15 mgd of desalinated water and to provide a reliable, drought-proof alternative to the construction of a new pipeline for supplemental water supply from the already over-allocated Russian River.

Marin Municipal Water District has recently completed a 12-month desalina-

tion pilot test and preparation is well under way of an environmental impact assessment for this project; a draft EIR was expected to be circulated for public review by the end of 2006.

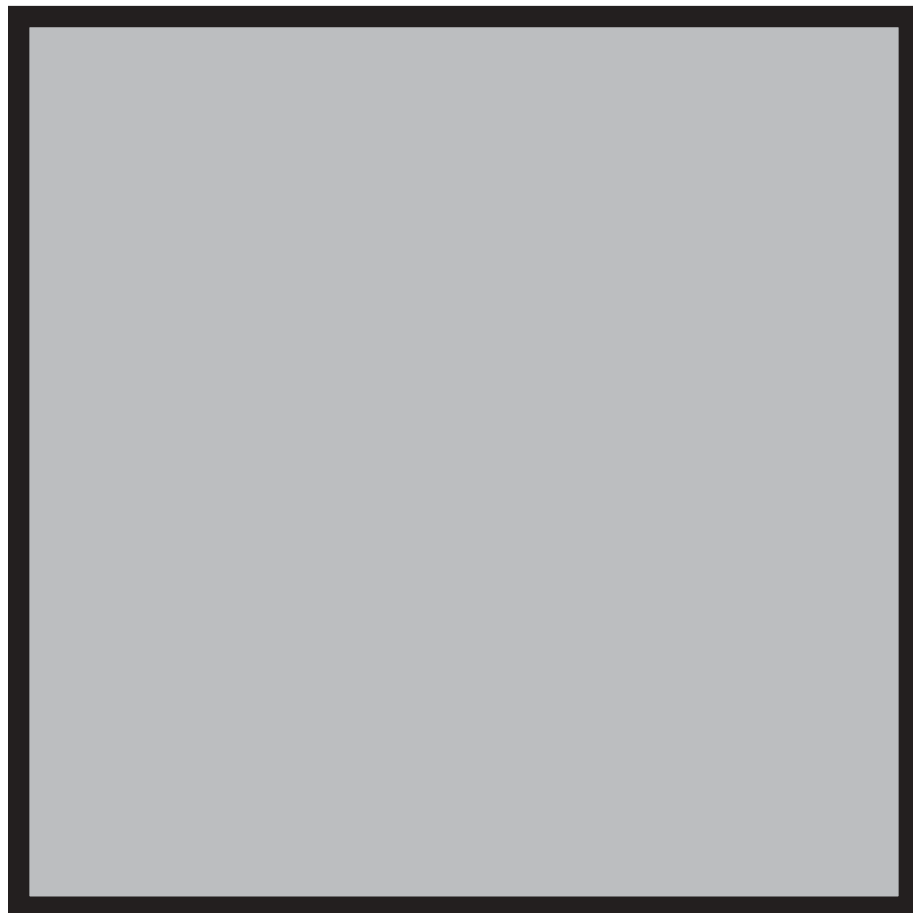
Similarly, the main purpose of the large seawater desalination project proposed for the City of Moss Landing in Monterey County is to alleviate further over-pumping of the Monterey Bay coastal aquifers and to comply with the state-mandated curtailment on withdrawal of fresh water from Carmel River because of the detrimental impact of said withdrawal on the salmon population in the river.

It is also interesting to note that while the report emphasizes desalination's potential to induce population growth, it remains completely silent on the fact that if additional water is made available through more aggressive water conservation or water reclamation, this water has equal potential to create growth inducement. This subjective double-standard approach is intertwined in practically every aspect of the report's analysis of desalination viability and is one of the major flaws of the document. PI's subjectivity leaves the impression that the authors are trying to oversell water reuse and conservation at the expense of desalination.

The reality is that except for the authors of the report and a few radical supporters, the majority of California's population, the state government and the proponents of the desalination initiatives, all agree that securing a sustainable water future for California demands a balanced portfolio which includes all four key types of water supply sources: conventional water supplies, reuse, conservation and desalination. None of the proponents of the ongoing desalination projects even contemplates replacing water reuse and conservation with desalination. Quite the opposite: most utilities considering the development of large desalination projects also have in place comprehensive long-term water reuse and conservation programs and plan to enhance such programs simultaneously with the implementation of their desalination initiatives.

### ***Is desalination affordable for Californians?***

The PI report indicates that one of



the major reasons for California desalination's 'immaturity' is its lack of affordability. Currently, the cost of desalinating seawater in California is relatively higher than that of traditional low-cost water sources (groundwater and river water) and water reclamation and reuse for irrigation and industrial use. Indeed, the cost of traditional local groundwater water supplies in some parts of the state is as low as \$0.5/1,000 gallons (\$160/acre foot [AF]). However, the quantity of such low-cost sources is very limited (less than 30 percent of water resources statewide). For example, notwithstanding that over 40 percent of the current Orange County water supplies are in this category, that county's water agencies have embarked on exploring seawater desalination because practically all available fresh aquifers currently delivering this low-cost water are tapped-in and over-drafted. Most of the utilities in southern California currently purchase imported water from the Bay Delta and Colorado River at a rate of \$1.5 to 1.8/1,000 gallons (\$500 to \$600/AF) and the cost of these water supplies is very likely to increase by 10 to 15 percent in the next five years due to additional expenditures needed to comply with more stringent drinking water quality regulatory requirements recently promulgated by the US EPA.

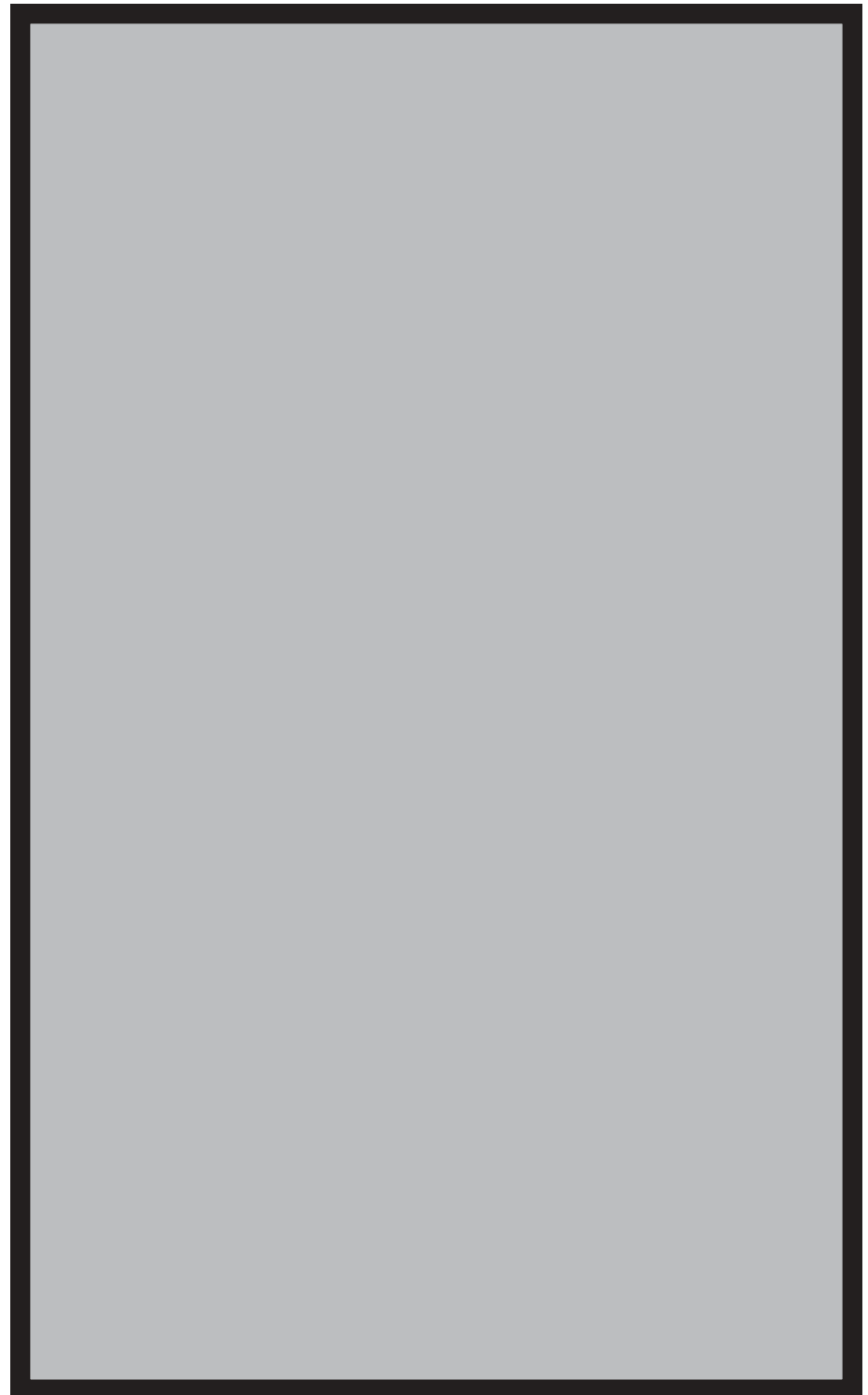
Based on the *2006 California Water Charge Survey* published in July 2006 by Black & Veatch ([http://www.bvaeservices.com/news/articles/jul06/ca\\_survey\\_businesswire.htm](http://www.bvaeservices.com/news/articles/jul06/ca_survey_businesswire.htm)), the average residential monthly charge for 1,500 cubic feet of drinking water was \$36.39 (\$3.24/1,000 gallons or \$1,058/AF). The survey also indicates that the cost of residential water supply has increased by 16.7 percent since 2003.

Meanwhile, the cost of desalinated water has been decreasing steadily over the last 10 years and the majority of the projects included in the California desalination initiative, declared premature by the PI report, are projected to produce water at a cost of \$2.6 to \$3.7/1,000 gallons (\$850 to \$1,200/AF). These costs are estimated based on an asset life of 30 years and unit power costs of \$0.08/kWh to \$0.11/kWh. Therefore, if we follow the gem of advice in the PI report that, "cost comparison must be made on comparable basis," then the costs for production of desalinated seawater would be similar to the future total costs for delivery of new incremental water supplies to many parts of the state, especially to municipalities and utilities in southern California relying on imported water supplies.

The PI report uses the argument that desalinating seawater and brackish water is generally more expensive than the production of reclaimed water and the implementation of water conservation measures. This argument however, is fatally flawed by the fact that water conservation and reuse do not create new sources of drinking water—they are merely a rational tool to maximize the beneficial use of the available water supply resources. Under conditions of prolonged drought when the available water resources cannot be replenished at the

rate of their use, aggressive reuse and conservation can help but may not completely alleviate the need for new water resources and water rationing. Simply put, if your backyard well is dry you cannot resolve your household water supply challenges by reusing or conserving more of the well water you do not have.

A real-life example is the period of prolonged drought in California in the early '90s, which created the need for emergency fast-track implementation of a number of water desalination projects, despite the fact that some municipalities,



such as the City of Santa Barbara, had reduced their water use by nearly 40 percent by aggressive conservation measures. While the relatively high cost of seawater desalination (\$4.6 to \$6.1/1,000 gallons or \$1,500 to \$2,000/AF) and the available low-cost reclamation and reuse measures combined with a period of several wet years following that long drought marginalized the benefits of seawater desalination at that time, the water conditions, costs and challenges California faces today are very different.

The main differences stem from the significant reduction of the costs for seawater and brackish water desalination over the last 10 years and the incrementally higher costs associated with achieving dramatic increase in water reuse and conservation statewide after the initial set of low-cost/high-effect water reclamation and conservation measures are implemented. While in the early '90s extensive conservation and reuse were uncommon for the majority of the municipalities in California, the prolonged drought during this period forced many utilities to implement low-cost water reuse and conservation measures that now constitute 5-15 percent of their water portfolios. Utilities which already have comprehensive water reuse and conservation programs will not be able to squeeze another 10 or 15 percent of water savings via the same low-cost reuse and conservation measures. Implementing the next tier of more sophisticated equipment and technology-intensive reuse and conservation measures to reach water-saving goals of an additional 20-25 percent comes at a price which, in some cases, may approach that of desalination.

In addition, seawater desalination cost benefits extend beyond the production of new water supplies. If desalination is replacing the use of over-pumped coastal or inland groundwater aquifers, or is eliminating further stress on environmentally sensitive estuary and river habitats, then the higher costs of this water supply alternative would also be offset by its environmental benefits. Similarly, desalination provides additional benefits in the time of drought where traditional water supplies may not be reliable and their scarcity may increase their otherwise relatively low costs.

### **Will desalination 'break the back' of California's power supply system?**

Desalination is more power inten-

sive than conventional treatment of fresh water sources because it requires additional energy to overcome the naturally occurring osmotic pressure exerted on the reverse osmosis (RO) membranes by the saline water source (ocean or brackish water). Table 1 presents the energy use associated with various California water supply alternatives. The table does not incorporate the costs associated with raw water treatment of the surface water imported from the Colorado River project and supplied by the State Water Project and product water delivery costs for any of the listed alternatives.

It is interesting to note that the PI report contains a number of factual inaccuracies which indicate the authors' superficial understanding of the factors affecting the energy demand associated

**Table 1. Energy use of various water supply alternatives**

Water supply alternative	Energy use (kWh/AF)
Conventional treatment of surface water	200 to 300
Raw water imported by state water project (without treatment)	3,000 to 3,500
Raw water imported from Colorado River (without treatment)	2,000 to 2,500
Water reclamation	500 to 1,300
Brackish water desalination	850 to 1,500
Desalination of Pacific Ocean water	2,800 to 3,600

Note: one kWh/1,000 gallons = 326 kWh/AF

with seawater desalination and the contribution of power expenditures to the overall cost of water production. Based on reference to energy use of projects in Israel, the Middle East and Spain, where ocean water has approximately 20 percent higher salinity than the Pacific Ocean along the California coast, the report concludes that even if best available technologies are used, the power demand for production seawater desalination will be 12 kWh/1,000 gallons (3,912 kWh/AF). In fact, since the Pacific Ocean has lower salinity than the referenced locations, the energy needed to produce desalinated water ranges between 8.6 and 11 kWh/1,000 gallons (2,800 to 3,600/kWh/AF).

The PI report remains silent about the outstanding efforts of the California-based Affordable Desalination Collaboration (ADC) which recently completed a study to demonstrate what the currently available state-of-the art desalination technology can do to reduce energy use for seawater desalination. ADC is a non-profit organization composed of leading companies and public agencies

involved with seawater desalination. The expert-reviewed results from over one year of operation of the ADC seawater desalination demonstration facility located at the US Navy's Desalination Research Center in Port Hueneme, California validate the energy consumption values included in Table 1 and also indicate that in the not-so-distant future the power use for seawater production can be reduced even further (see [www.affordabledesal.com](http://www.affordabledesal.com)).

The PI report contains another inaccuracy with important implications regarding the viability of seawater desalination in California. Without normalizing data from foreign desalination plants for the site-specific conditions in California (labor, construction, equipment costs, etc.) the report stipulates that

electrical energy accounts for 44 percent of the total water production costs of a typical membrane seawater desalination plant and 60 percent of costs for thermal water desalination. In fact, due to site-specific differences, the power costs for seawater desalination in California would contribute only 20-30 percent of the total costs of water production. The PI report draws the erroneous conclusion that the fluctuations in international fuel markets will have a dramatic effect on the viability of desalination; it also misses the

point that energy cost increases will also have the same incremental effect on all water supply alternatives in California. According to a report prepared by the California Energy Commission, the current power demand of the water sector in California (including both water and wastewater conveyance and treatment) totals 13,341,000 mWh. Assuming a conservative unit energy use for seawater desalination of 11 kWh/1,000 gallons, the total energy needed to produce 450 mgd of drinking water is 4,950 mWh, which is only a 0.037 percent increase of the current California water sector energy demand. Based on these facts, it is erroneous to conclude that the current desalination initiative would 'break the back' of the California energy supply system, nor could such be objectively used as a valid argument for rejection of the viability of seawater desalination in California. This assessment also diffuses the PI report's claim that, "desalination facilities exacerbate climate change with their large use of energy," and that it, "can contribute to greater dependence on fossil fuels".

It should also be pointed out that an objective analysis of the energy use for seawater desalination should take into consideration that while the energy use for production of desalinated water is projected to decrease further (by 10-20 percent over the next five years, as a result of advancements in membrane and energy recovery technologies), the total energy demand for conventional water treatment would increase (by 15 to 20 percent) in the same timeframe because of the energy demand associated with the additional treatment (such as micro- or ultra-filtration, ozonation, UV disinfection, etc.) which would be needed in order to meet the most recent regulatory requirements for production of safe drinking water.

### ***How unique is the impact of desalination operations on the environment?***

The PI report points out two key areas of desalination project impact on the environment: the effect of their high-salinity discharge on aquatic life and the potential impingement and entrainment of plant intake facilities. Although the report claims that safe disposal of plant concentrate is a challenge, it fails to mention that there are over two decades of

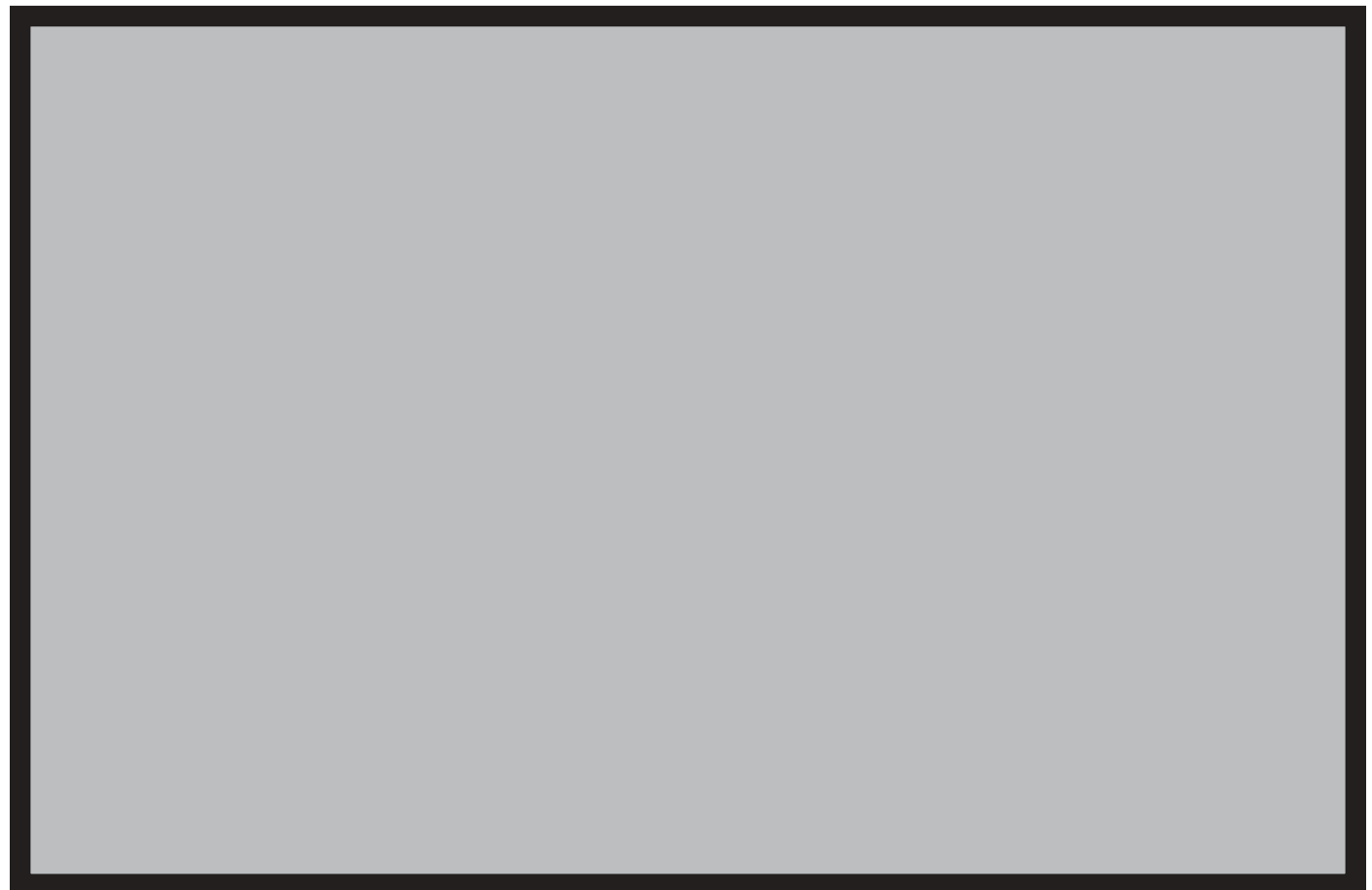
experience of safe concentrate disposal from both seawater and brackish water desalination plants in the US and worldwide. It also ignores that there are no known cases where desalination discharges have actually caused significant environmental alterations of the ambient aquatic environment. In recognition that desalination plant concentrate can be managed without any measurable challenges, after rigorous technical and scientific review and analysis, in the summer of 2006, the San Diego and Santa Ana Regional Water Quality Control Boards granted waste discharge permits to the 50 mgd Carlsbad and Huntington Beach desalination plants. These permits encompass desalination plant concentrate and the other side-streams (membrane cleaning solutions and pretreatment filter backwash) generated at the desalination plants.

The PI report claims that "impingement and entrainment of marine organisms are among the most significant environmental threats associated with seawater desalination". This claim, however, is not supported by any data nor by any full-scale studies of existing seawater desalination intakes; neither is it substantiated by the observations and/or monitoring of aquatic life in the vicin-

ity of plants operating along coastal Spain, Israel or Australia—countries which have stringent regulations and elaborate legal and monitoring frameworks for protecting marine environments, comparable to that of California. The report also remains silent on the fact that existing state water project's open intakes along the Sacramento Bay-San Joaquin Delta collect source water from aquatic environments that are much richer in life and more fragile in ecological balance than the bare ocean bottom areas in the vicinity of most of the proposed open-intake seawater desalination intakes and the fact that these fresh water intakes collect an order-of-magnitude larger volume of water than the proposed desalination projects. This subjective review of environmental impacts of the desalination plants underrates the authors' 'genuine' concerns regarding the impact of various water supply practices on California's environment and the fair comparison of this impact.

### ***How does desalinated water quality fare against other alternatives?***

The PI report states that use of desalinated water can be a cause of health concerns and may result in water distri-



bution system corrosion. Using outdated information regarding boron rejection of seawater membranes, the report claims that desalinated seawater can contain boron at levels exceeding the applicable safe drinking water requirements. The report states that "RO membranes can remove only between 50 and 70 percent (of the 4.5 mg/L of boron contained in the ocean water) and therefore may exceed the California Department of Health Services Action Level for boron of one mg/L."

Practitioners of seawater desalination know well that the quoted boron removal levels refer to membranes that are two generations old. Currently available seawater desalination membranes can reject over 90 percent of the boron contained in the seawater and according to the September/October 2006 issue of the International Desalination Association's *Water News*, "research is underway to achieve 93 to 95 percent boron removal."

Similarly, using outdated information or misinterpreting existing studies or data, the report raises unfounded concerns regarding other water quality parameters such as disinfection byproducts (DPBs), algal toxins and mineral content of the desalinated water. The report fails to acknowledge that over two dozen large, existing brackish water desalination plants in Florida have been successfully supplying drinking water (of quality and corrosion potential similar to that of the proposed California desalination plants) for over 15 years without health or distribution system related problems. Similarly, the hundreds of seawater desalination plants worldwide have been providing safe potable water of reliable and consistent quality for over two decades without causing problems such as the 1993 *Cryptosporidium* outbreak in Milwaukee, Wis. or the recent corrosion-related lead water quality challenges in Washington, D.C.

Although desalinated water from the numerous existing brackish water desalination plants in California have been distributed to the public water supply for decades, the report makes the erroneous statement that the, "overall effects of desalinated water on California water distribution systems are not yet known." Obviously, they are—but apparently not to the writers of the PI report.

### Summary and conclusions

The recently published Pacific Institute report offers a subjective opinion of the viability of desalination in California that self-servingly renders most of the ongoing desalination initiatives immat-

ure. What is immature, however, is the knowledge and understanding of the report's authors of the current status of desalination technology and their understanding of the critical importance of the development of a diversified water portfolio that includes a well balanced mix of conventional water supply sources, water reclamation, conservation and desalination for the long-term sustainability of the California water supply and socioeconomic development of the state.

PI report's opinion is not shared by the people of California, who in 2002 voted in support of *Proposition 50*, opening the opportunity for exploring brackish and seawater desalination as a new and reliable source of water supply for the state. Nor it is endorsed by the California Department of Water Resources, which incorporated the development of 450 to 500 mgd of new desalination projects into their 2005 *California Water Plan*.

The key fatal flaw of the report is that it fails to recognize the wealth of international and domestic desalination experience and to understand the applicability of this experience to the site-specific conditions of California. Rather than pointing to proven solutions and state-of-the-art knowledge associated with the use of desalination technology, the report tries to paint a picture of a water supply technology of enigmatic problems and effects unknowable and "not yet seen" in California. Proving the century-old Will Rogers line that "common sense is not that common", the Pacific Institute desalination report contributes little practical value or constructive input toward solving California water challenges and provides no useful, up-to-date information for readers interested in gaining an accurate and objective understanding of the challenges and solutions associated with the use of desalination today.

Recognizing the value and importance of desalination for the state over the next five to 10 years, many California communities plan to make desalination a permanent part of their water portfolio. Approximately 20 medium and large desalination plants supplying up to 5.7 percent of California's total urban water demand are projected to be built by the year 2015. Although existing fresh water sources, conservation and reuse will continue to play a central role in the state's long-term water supply strategy, seawater desalination has unique appeal to many coastal communities because it allows access to a reliable and drought-proof source of drinking water that can be developed and controlled locally at

costs competitive to incremental expenses associated with the development of other water supply alternatives.

### About the author

◆ *Nikolay Voutchkov has over 20 years of experience in the field of seawater desalination and water and wastewater treatment. He is a Senior Vice President and Corporate Technical Director for Poseidon Resources, a US company specializing in the development of large water infrastructure projects. His areas of expertise include: pilot testing and full-scale implementation of membrane treatment technologies for production of potable water from seawater and industrial water reuse; assessment of the effects of seawater desalination plant discharges on the marine environment; and product water quality integration of desalinated water with other sources of potable water. Voutchkov is author of over 40 technical publications and co-author of several books in the field of desalination, water and wastewater treatment and reuse. Currently, he is one of the principal authors of the American Water Works Association's updated "Manual of Water Supply Practices" (AWWA M46) on reverse osmosis and desalination. Voutchkov is a registered Professional Engineer, a Diplomat of the American Academy of Environmental Engineering and has received a number of prestigious awards and a patent for his work in the field of desalination. He is a member of the American Membrane Technology Association, the International Desalination Association, the American Water Works Association and the International Association on Water Quality. He can be contacted at Poseidon Resources Corporation, 1055 Washington Boulevard, Stamford, Conn. 06901, USA; telephone (203) 327-7740; fax (203) 327-5563 or via email at [nvoutchkov@poseidon1.com](mailto:nvoutchkov@poseidon1.com). Company website: [www.poseidonresources.com](http://www.poseidonresources.com)*



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