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Desalination: Unlocking Lessons from Yesterday's Solution

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There is powerful information waiting to be unleashed in water data. If it were set free it would force us to re-think how we use, develop, sell, transfer, and dispose of water. Rather than focusing on the miles per gallon our cars get, we might consider how much water per mile that fuel's production required. Rather than arguing over how much energy is being used to produce water, we would give credit to how much water is required to produce energy. Rather than focusing on whether our food is grown locally, we would consider how much water it took to grow that food in our locality.

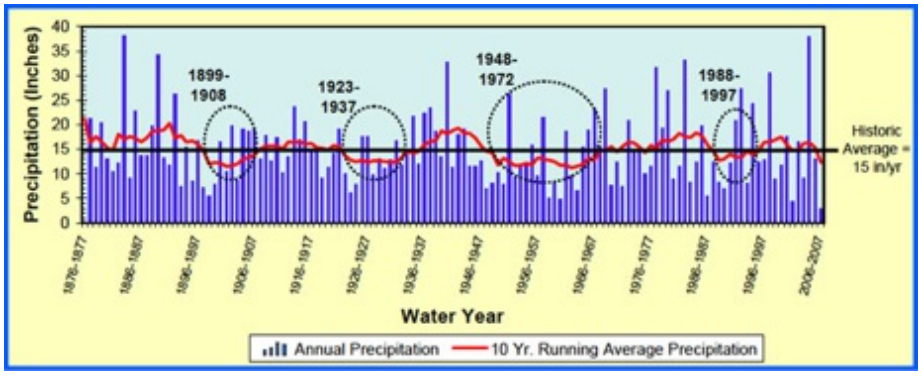
For all the lip-service we give to water and its pivotal role, why is there not a U.S. Water Information Administration modeled after the U. S. Energy Information Administration? Established in 1977 as a response to the 1973 oil disruptions, the EIA "collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment." With a budget of $111 million per year, the agency produces data and analysis free of influence from the Executive Branch. The water sector screams for such a resource.

Sunset at Huntington Beach, California. Source: paige_eliz on Flickr.

My particular interest in water began in 2003 when I served on the California Desalination Task Force, a group appointed by the State Legislature to look into the opportunities and impediments of desalination. Data is at the heart of reaching conclusions on a technology. Where did the data come from that allowed the committee to write its findings and recommendations? Who verified the veracity of the data? Would it stand up to scrutiny? I have spent eight years chasing such questions.

Information is not easy to come by. There are over 52,000 public and private water utilities in the U.S alone operating largely in anonymity. Public utilities offer varying levels of transparency, private utilities virtually none. The desalination industry consists of over 30,000 companies producing membranes, tanks, chemicals, pipes, monitoring, design, construction, mitigation, engineering, drilling, waste management, and consulting services. Many are competitors and hold data close to the vest. Foraging through public information, industry publicity, scientific papers, and news stories produces information that is contradictory and confusing.

There are 19 desalination projects proposed for California's coast. With billions of dollars at stake, the public deserves more clarity on financial and environmental impacts. What are the assumptions that underlie our decisions to move forward? What issues are being left unaddressed? What lessons have we missed that could inform better water planning? Water agencies may be satisfied with the industry's propaganda, but my research suggests they should pause and re-examine where we have been and where we are going.



Los Angeles annual rainfall 1876-2007. Will cyclical weather patterns turn desalination plants into expensive orphans? Source: Data from Los Angeles Almanac.

Remembering the past

Desalination proponents throw out numbers that cannot be verified or replicated and those numbers are repeated by the media and government officials as if they were fact.

An article published by the Los Angeles Times on December 4, 2010 is an example.

> "Although still not cheap, the cost of desalinated water has been cut by more than half since 1998, according to the U.S. Geological Survey."

I contacted the reporter to find the source of this statement and received no reply. I searched the USGS website and found an out-of-date overview of desalination with an a unsourced sentence

that looked like it might be the culprit of the reporter's "fact."

> "As of 1998, the high cost of desalination has kept it from being used more often, as it can cost over $1,000 – $2,200 per acre-foot (1992 cost basis) to desalinate seawater as compared to about $200 per acre-foot for water from normal supply sources. Desalination technology is improving and costs are falling, though, and Tampa Bay, Florida is currently desalinizing water at a cost of only $650 per acre foot."

Thinking there might be additional data available from the USGS, I contacted them. They were unable to direct me to any reports or studies to verify the veracity of the claim that Tampa Bay is producing water at $650 an acre-foot. Most likely the figure came from the original presentations made to Tampa Bay Water over a decade ago. Price was probably the motivating factor in Tampa Bay's decision to construct a project, but as NOAA stated in a 2003 publication, "Time will not only tell the environmental impacts of Tampa Bay's desalination plant, but it will also determine if it's really producing the cheapest desalted seawater in the world." It would be wonderful if time did tell its secrets. Unfortunately for truth seekers, time may tell but will anyone be listening.

Last March, according to Tampa Bay's General Manager, the cost of production was $1140/acre-foot. It's anyone's guess how he came up with that figure. If you calculate the marginal cost of water based on what the plant has actually produced since 2003, then the cost of water is closer to $1826/acre-foot. Either way, the L.A. Times reporter did the public a disservice by perpetuating the myth that desalinated water can be produced at $650 per acre-foot. I could almost hear the gullible politicians jumping on board.

The reporter could have provided a valuable public service had she written about Tampa's twelve years of bankruptcies, technical challenges, and cost overruns. A search of news archives produced an interesting collection of stories, likely with similar fact checking issues, but nevertheless, interesting for the overall picture they paint.

- 1998 engineering contract awarded to Stone & Webster
- 2000 Stone and Webster declares bankruptcy
- 2001 Covanta (partnering with Poseidon Resources) hired to construct and operate for 30 years at $7 million/year
- 2003 (March) initial output begins producing 3 million gallons but acceptance test fails
- 2003 (August) plant is shut due to clogged filters
- 2004 Tampa Bay pays $4.4 million for Covanta to go away
- 2004 (September) American Water Services hired to fix plant at cost of $29 million. Completion projected for 2006.
- 2006 (January) Agreement reached between Southwest Florida Water Management District (Swiftmud) (agency funding $85m of project) and Tampa Bay for payments: 25% when plant is running, 50% when it operates at an annual average rate of 12.5 mg/d for 12 consecutive months, 25% when plant produces 25 mg/d for four consecutive months.
- 2006 (November) Tampa Bay Executive Director announces additional delays
- 2007 (August) Tampa Bay announces plant should be running by Halloween
- 2007 (December) Officials complete 14 day acceptance test. American Water contracts to run plant for 15 years.
- 2008 $48 million over its original budget of $110 million, the plant is operating
- 2009 plant producing 16-19 mg/d
- 2010 (February) plant passes final benchmark, receives final payment
- 2010 (April) plant put on "standby" due to Tampa Bay's budget constraints
- 2010 (October) Pinellas County (customer of Tampa Bay Water) projects water rate

increases of 16% by 2014
- 2010 (December) SWFMD looks into sanctions against Tampa Bay Water for failure to operate facility in accord with agreement.
- 2011 (January) Tampa Bay announces plans to reach 9 mg/d production by end of January.

Reviewing the news accounts of the Tampa Bay experience gave me pause. Having served in public office, I am familiar with the face-saving, "circle the wagons" mentality that takes over an agency when problems start to mount. Unfortunately, it means others are not likely to learn any lessons.

No one contemplated a standby plant at Tampa Bay. Now, faced with real production costs higher than the rate guaranteed to customers ($841/acre-foot versus $1140 or more), Tampa Bay will eventually have to raise rates or renegotiate an agreement that locks them into a 17 mg/d production rate.

Exhume the dead

Everyone has skeletons in their closets, desalination is no exception. Burying them does a disservice to the millions of public dollars that have been invested. Let's celebrate their weaknesses so that we may never repeat their mistakes. There may be many dozens of such projects, but here are a few that have experienced their share of controversy: Santa Barbara, Key West, Santa Catalina, Yuma.

- Santa Barbara's project was mothballed before a single drop of water was introduced into its distribution system.
- Key West built a 130 mile pipeline and implements water rationing when necessary, thus avoiding operation of its plant.
- Catalina Island hasn't operated its plant in years, relying on price signals with water rates that are perhaps the highest in the nation. Their top water tier is over $10,000/acre-foot. In response to the utility's rate increase request, the California Public Utilities Commission had this to say about the Catalina facility: "...for Catalina Island in 2005, desalinated water accounted for only 25% of total water production, but desalination accounted for approximately 70% of total electricity usage." [Despite repeated requests, the operator, Southern California Edison, would not divulge information about the plants operation.]
- The 72mg/d Yuma desalter, constructed by the Bureau of Reclamation, was built to comply with a treaty with Mexico. It was completed in 1992, operated at 1/3 capacity for 6 months and then shut down in 1993. Other, less expensive options for treaty compliance made it unnecessary.

In addition to these projects, there are many pilot projects that litter Southern California. I've often wondered why every proposed project has to be preceded by a pilot project. There is one in Los Angeles County that has already expended $23 million of public money. It follows one built in Long Beach which follows one built in Carlsbad which follows one... You get the picture. It's insane.

Go slow, include all stakeholders

Australia began its desalination building boom in 2004 amid a prolonged drought, ultimately committing $10 billion for six projects. Public participation consisted of after-the- fact review of incomplete details. Construction contracts even contain redacted details of critical information. Decisions were made at the Cabinet level and one official's rationale for excluding the public was that information would be "incomprehensible" to the them.

Officials further aggravated their problems by approving multiple projects that competed with

each other for materials and labor. Perth, completed its first project in 2006 with the lowest projected water costs of $1677/acre-foot. Later projects came in significantly higher. The Productivity Commission, the government's independent research and advisory body, announced in July an investigation into the financial and environmental impact of Australia's water sector. A final report is expected in August. The number of customers seeking financial assistance has risen by 20% in two years. The auditor-general of Australia has estimated that the $5.7 billion Wonthaggi plant in Victoria will cost $24 billion over the life of its 28-year contract and water increases of 20% per year for five years have been recommended. The first political backlash occurred in November's elections where the Labor party took a beating. With rain returning and reservoirs rising to normal, the Queensland/ Gold Coast Tugun plant and Victoria's Wonghaggi plant are proposed to be placed on standby to ease the burden on ratepayers.

(Converted to U.S. dollars)	Consultant's presentation 9/11/09, OC, Calif.	Reported in The Australian 7/22/10
Perth I	$1172/AF	$1654/AF
Perth II		$2565/AF
Queensland/Gold Coast (Tugun)	$2932/AF	data not complete
Sydney	$1950/AF	$2724/AF
Victoria/Melbourne	$2550/AF	$1666/AF*
Adelaide (to open 2011)	$3033/AF	data not complete

*Figures vary significantly based on what costs are included in calculation. Melbourne's numbers are suspicious in that the plant will produce three times as much water as Perth's but cost seven times more to build.

Assess the weak links

Energy makes up the lions share of the costs of producing water, whether from the reverse osmosis process or a thermal process. Like the oft reported stories of "new energy" sources, the desalination industry is constantly bragging about new technologies that have reduced the energy demands of their process. I hope they are true, but until the industry can convert those promises into lower costs, they are no better than the hype of biofuels or perpetual motion.

Despite the widespread belief that the Middle East has unlimited energy resources, both water security and energy security are a real threat to their economy and world security. How long will the Middle East, where as much as 90% of water is coming from ocean desalination be able to afford the luxury of desalinated water? According to some reports, water rates in Saudi Arabia cover less than half of one percent of the cost of producing desalinated water. Subsidizing water, food, and gasoline is seen as a way of sharing the country's oil wealth. But the absence of any price signal has led to some of the highest per capita water consumption in the world, and highest greenhouse gas emissions in the world. According to a recent study, Saudi Arabia now ranks 6th in greenhouse gas emissions, half directly attributable to desalination. Authorities are straining under the burden of water and energy demands pushed by burgeoning population growth. Despite allocating $150 billion over the next five years for power and water projects, they have been forced to abandon their goal of becoming self-sufficient in wheat production. With natural

gas in short supply, the feedstock to produce electricity will continue to be oil. The irony is that oil revenues make up 90% of the Saudi government's budget so every barrel diverted to water is a barrel that cannot be sold on the market to fill state coffers.

The rising costs of energy are not just impacting the cost of electricity, they impact the entire desalination supply chain: mining of materials, (e.g. 6 million pounds of titanium alone are required for the world's largest desalination plant in Saudi Arabia); manufacturing and shipping of components; construction; continuous supply of chemicals that are derived from fossil fuels; maintaining equipment; and any necessary treatment for the discharged brine and chemicals. We have long assumed that water was the limiting resource for societies, but water is just the end product of a very long supply chain, with any link capable of affecting reliability.

Focus on affordable solutions

Worldwide, humans have quickly and wastefully consumed water from the cheapest sources by over-pumping aquifers and over-allocating rivers. We've turned to technology to eke out more but technology is not without its costs. Every remaining incremental gallon of water will come at a higher and higher price. Are we nearing a breaking point?

Prior to the 2008 run-up in oil prices, gasoline, like water, was widely believed to be inelastic– that consumption of such an essential commodity would grow despite the price. But as gasoline prices headed toward $4/gallon, discretionary spending shrank and the economy shrank.

The rising cost of essentials like food, shelter, energy, and water has a disproportionate impact on low income households. Low income assistance programs for water vary significantly from one jurisdiction or utility to the next. For example, in California, San Jose Water provides a 15% discount on the total bill while Valencia Water provides a 50% discount off the monthly service charge. Such programs shift the costs onto remaining consumers and businesses many of whom are themselves facing economic distress. Are these programs sustainable in the face of continuous water rate increases and growing economic challenges?

"A solution isn't a solution if it isn't affordable." Those were the cautionary words of Cuban energy expert Mario Avila who visited California in September of 2010. Cuba has lived through a number of energy crises. The one with which I was familiar was the oil shock that resulted from the collapse of the Soviet Union. But Mario explained that it was the lesser known electricity crisis following the 2005 hurricane season that exposed the vulnerability of their water system. Two power plants were destroyed by two storms plunging the island into relentless daily blackouts. Without electricity, water didn't move, it could not be treated, and it could not be discharged. Castro declared an "energy revolution" and within a six month window, thousands of "social workers" were deployed to inventory and replace every incandescent light bulb on the island and promote zero interest loans for efficient appliances. Rather than replace the two large power plants, the nation built smaller, distributed power plants improving the resiliency of their system and restoring power and water.

Resilience should be the goal of water planners but most options that improve resilience–water harvesting, conservation, demand management– receive a tepid reception. One major reason is because water providers are paid to sell water, not conserve it. And there isn't an ongoing assurance for funding conservation or efficiency. When budgets get tight, the conservation budget is the first to be eliminated as was done last year by Metropolitan Water District of Southern California (MWD). Ironically, while eliminating the conservation fund, MWD was approving subsidies for desalination and raising water rates because their conservation message had resulted in lower water consumption. Conservation and low tech options for reducing water demand will never compete against capital projects in the current regulatory framework.

Level the playing field

It isn't surprising that an industry that can't even quantify water in a consistent unit of measure (acre-feet, gallons, cubic meters, units, cubic foot), would apply different criteria to different water options. The result is a misleading comparison between options.

Here's an example. Say a proponent tells you that the new desalination project will produce water at $1000/acre-foot. You're told that your city is buying water from MWD for $750/acre-foot. The natural reaction will be to compare $750 to $1000. But MWD's actual production costs are closer to $200 of that $750 figure. That means $550 is covering their fixed costs. So even if you reduce your imported water by 10%, the remaining costs will have to be levelized across all water purchasers (including your city's 90% remainder). Communities that are not the recipients of the desalinated water will nevertheless be footing the bill through subsidies and cost sharing.

Similarly there has not been a fair method for comparing conservation measures to traditional water sources. For example, the cost effectiveness of rainwater tanks has traditionally been calculated by comparing the cost of installation against the savings on household bills. But this ignores the broader cost savings to the community in deferred water infrastructure, storm water infrastructure and environmental externalities like greenhouse gas emissions. When those are accounted for, rainwater harvesting is superior to desalination.

A model already exists for a regulatory framework that would address such conflicting motivations. In 1982 California became the first state to adopt an electric revenue decoupling mechanism. This gave utilities the incentive to promote conservation and efficiency because their ability to recoup their fixed costs was decoupled from the volume of their sales. In addition to decoupled rates, California has a "loading order" of energy preferences that place priority on the least expensive and most environmentally protective resources. When meeting California's energy needs, conservation and efficiency are considered before additional generation is added.

A sustainable conservation budget would give priority to cost effective programs like water capture, drip irrigation, water recycling, low-flow devices, and water management programs that reduce demand, costs, and bring true resilience to the water sector.

Left to compete on an uneven field, conservation will remain the bastard step-child to desalination. In 2006, many communities in Australia were offering substantial rebates on water tanks. By 2007, demand was so high that prisoners were put to work building tanks. Government leaders, buoyed by studies that demonstrated other options as more cost effective than desalination, pledged $250m toward their goal of reaching 500,000 households. Then in 2008, with the collapsing economy and in the midst of the desalination boom, the Bligh government dismissed wide scale rollout of water tanks. Some officials sensed a threat of competition to their capital projects, going so far as to suggest the licensing of water tanks so as to enable levying taxes on rainwater collected.

Remove the rose-colored glasses

Technology has its place. But it is not magic and shouldn't be seen as the solution to all our problems. That which is technologically feasible is not necessarily economically feasible. Desalination cannot be "greened" by utilizing solar or wind energy for its energy requirements. Not only is the scale of such a proposal ginormous, it ignores the fact that all renewable energy resources are backstopped by fossil fuels. Moreover, the price of such a proposal would significantly increase the cost of desalination, exacerbating the economic problems of water pricing and availability.

Perhaps the most important lesson I have learned over the past eight years of observing the desalination and water industry is that we create our own problems. And we are stuck in a perpetual feedback loop applying fixes to yesterday's solutions. That's the perfect recipe for rear-ending our future. The remedy is to increase our awareness of unintended consequences and the dynamic relationships between water, the environment, and human settlements. It is a systems thinking approach that starts with a willingness to open our minds and apply critical thinking.

To that end, I welcome all participants.