OCEANS INTO TAP WATER

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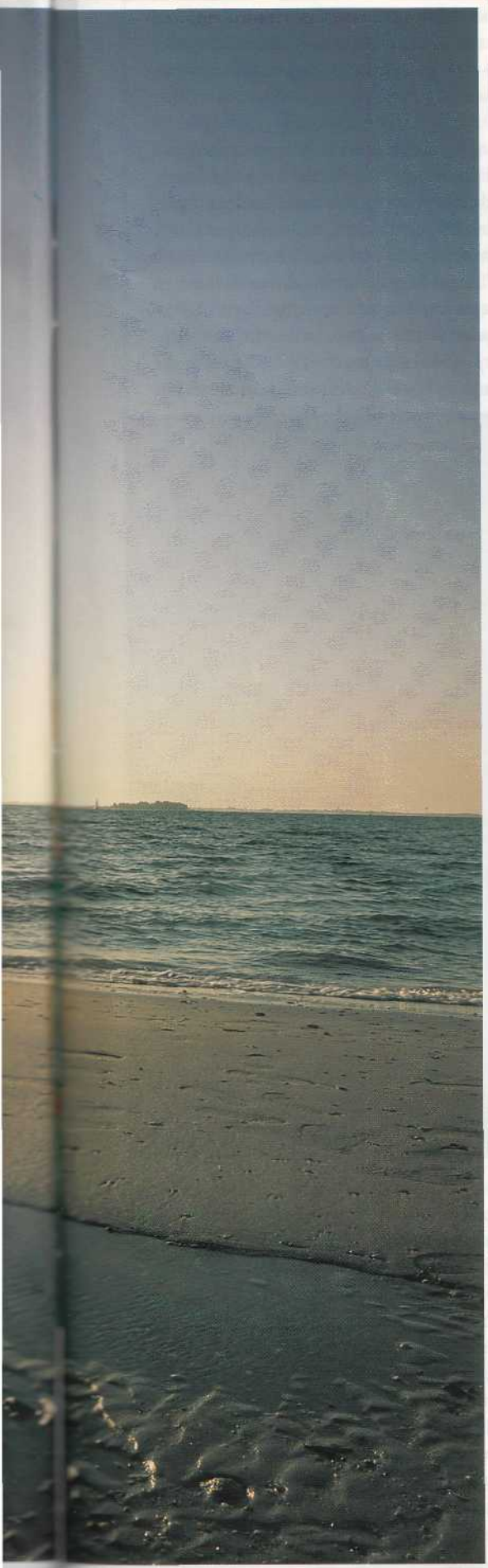
TURNING OCEANS INTO TAP WATER

DESALINATION PROMISES TO RESCUE SPRAWLING COMMUNITIES IN DIRE NEED OF FRESHWATER. IS THAT A GOOD IDEA?

BY TED LEVIN



Brackish water—such as these shallow flats off Apollo Beach—is much cheaper to desalinate than salt water from the ocean.

PHOTOS BY BRIAN SMITH

America is running out of drinking water. In parts of the arid West, this is literally true. In coastal areas, such as Pinellas County, Florida, the problem more closely resembles Coleridge's famous verse, "Water, water, every where/Nor any drop to drink." To slake its thirst, the local water authority, Tampa Bay Water, has built the largest desalination facility this side of Saudi Arabia. Situated on Apollo Beach, just across Tampa Bay from the Pinellas Peninsula, the plant is the only operational commercial desal facility in the United States. Eventually it will supply the region—a three-county area with more than two million people and growing—with 10 percent of its drinking water. (The rest will come from a now depleted aquifer, a new groundwater supply, and several aboveground rivers.)

The Apollo Beach plant may be a very good idea or a very bad one. It all comes down to this: Is desalination a legitimate response to a bona fide emergency, or is it simply an enabler for unchecked sprawl in fragile coastal areas that do not have the natural means to support their exploding populations?

Pinellas County, home of lovely St. Petersburg, is bounded on the west by the Gulf of Mexico and on the south and east by Tampa Bay. The soil is sandy and porous, perfectly suited for the engineering works of gopher tortoises. The beaches are classic Florida, bone-white sand lapped by blue water, beneath a wide arc of subtropical sky. In 1539, when Hernando de Soto marched up the Gulf coast, the Pinellas Peninsula was an open woodland of pines and palms and oaks. A dense coif of mangroves punctuated by salt marshes rimmed Tampa Bay, while the bay itself, covering nearly 400 square miles, was a mosaic of sea grass beds and oyster bars, mudflats and

open water. In season, birds from across the continent convened in and around Tampa Bay to gorge themselves on the flats and beaches and in the woodlands and shallows, where shoals of fish moved from the Gulf to spawn or feed in the fecund estuarial waters. Sea turtles nested on the beaches. Manatees grazed the sea grass beds. Back then, before the dredging of shipping lanes, a man could have threaded his way across the shallow bay without wetting his hair.

Tampa Bay remained a symphonic wilderness well into the nineteenth century, but its despoliation was swift. In the late 1880s, the hub of Pinellas County was an unnamed community, population 30. In 1892, the community incorporated into St. Petersburg, population 400. Early in the last century, to meet future water needs, Pinellas County and the city of St. Petersburg bought land in the hinterlands of Pasco and Hillsborough counties, north of Tampa Bay. Eleven well fields set in remote wetlands supplied the city with the potable groundwater that the peninsula itself could not provide.

By 1920, the population of Pinellas County had reached 28,000. Five years later, after a six-mile bridge was built to connect Pinellas County and Tampa, the population had grown to 50,000. By 1950, it was 159,000. By 1970, it had soared to 522,000. Today, as Pinellas County's population reaches nearly a million, Pasco and Hillsborough counties have undergone population explosions of their own, further stressing the well fields. Surrounding wetlands have become fire hazards and nearby lakes have receded from their shores. The faucets of some Pasco County residents literally have run dry.

A century of dredging, filling, building, and digging has destroyed 80 percent of the sea grass beds and more than 40 percent of the mangroves and salt marshes. Storm water runoff from cities and farms and the dumping of untreated sewage continue to strangle Tampa Bay. Nitrogenous compounds from coal-fired power plants and automobile exhaust fall out of the air, lacing the rain with toxins and turning the bay's gin-clear water into an opaque algal soup that has smothered the sea grass beds.

Only 3 percent of the earth's water is fresh, and more than two-thirds of that is bound up in glaciers and ice caps, rock-hard and beyond reach. This leaves less than 1 percent of the planet's water available for drinking and washing and mixing with bourbon, and that meager amount is not evenly distributed.

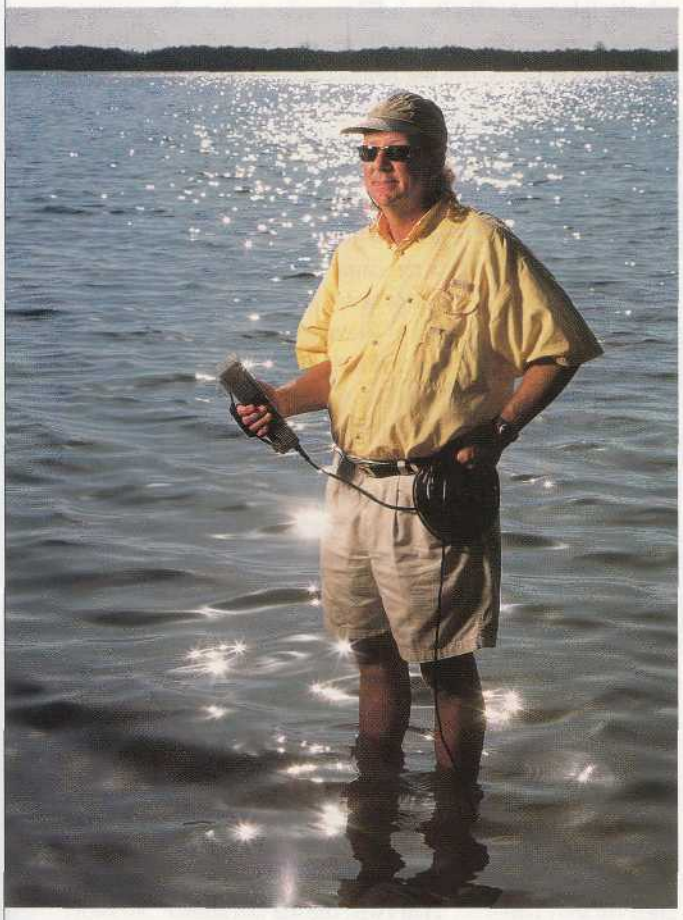
On the face of it, the Tampa Bay region would seem to have an abundance of aqueous resources. Buried among the layers of sedimentary rock beneath Florida and its continental shelf lies an ancient bubble of freshwater, the Floridan Aquifer, one of the largest in the world. Like the state, the aquifer is bounded on three sides by salt water. The layered rocks hold roughly two quadrillion (that's 2,000,000,000,000,000) gallons of water. To this hefty amount add 50,000 miles of rivers and streams, nearly 8,000 lakes and ponds, and 600 springs, some so large they become navigable rivers when they reach the surface. All this water sits on, or under, or slices through, more than three million acres of wetlands. When compared to other Sun Belt states, Florida appears submerged in good fortune. The question arises, then: Why are the 11 well fields that serve the greater Tampa Bay area running out of water?

One reason is that groundwater does not behave like surface water. Wells take longer than lakes to recharge, and the lower pressure created by depleted wells pulls surface water downward. The more water drawn out of a well field, the deeper and wider the zone of lower pressure, and the more surface water fills the void.

As surface water drains away, wetlands dry out, and even though particular localities sit atop a subterranean sea of freshwater, they may suffer a dramatic loss..

Prior to the passage of the state's 1972 Water Resources Act, which established five regional water management districts within the Florida Department of Environmental Protection, anyone could drill anywhere. After 1972, the water management districts began to issue consumptive use permits. Twenty years later, when Pinellas County's groundwater permits expired and Pasco County balked at having them renewed, the crisis moved from the faucets to the courts, eating up millions of dollars in legal fees.

In 1997, after a lengthy and contentious review process, the Southwest Florida Water Management District agreed to cofund a search for new supplies of freshwater for the Tampa Bay area. In an effort to alleviate Pasco County's water shortage, the water management district agreed to scale back pumping of the well fields. The goal was to reduce the level of pumping by more than half—from 192 million gallons a day (mgd) in 1996 to an eventual low of 90 mgd by 2008. This reduction, hydrologists hoped, would be enough to restore the health of the aquifer. By 1998, continued water shortages forced the governments of Hillsborough County, Pasco County, Pinellas County, St. Petersburg, New Port Richey, and Tampa to try something new. They decided to commission the construction of what would be the largest desalination plant in the country.



Far left: Tampa Bay's desal plant was built next door to the Big Bend Power Plant, which provides a ready source of water and energy. Left: Oceanographer Mark Luther uses a handheld sensor to measure temperature and salinity levels.

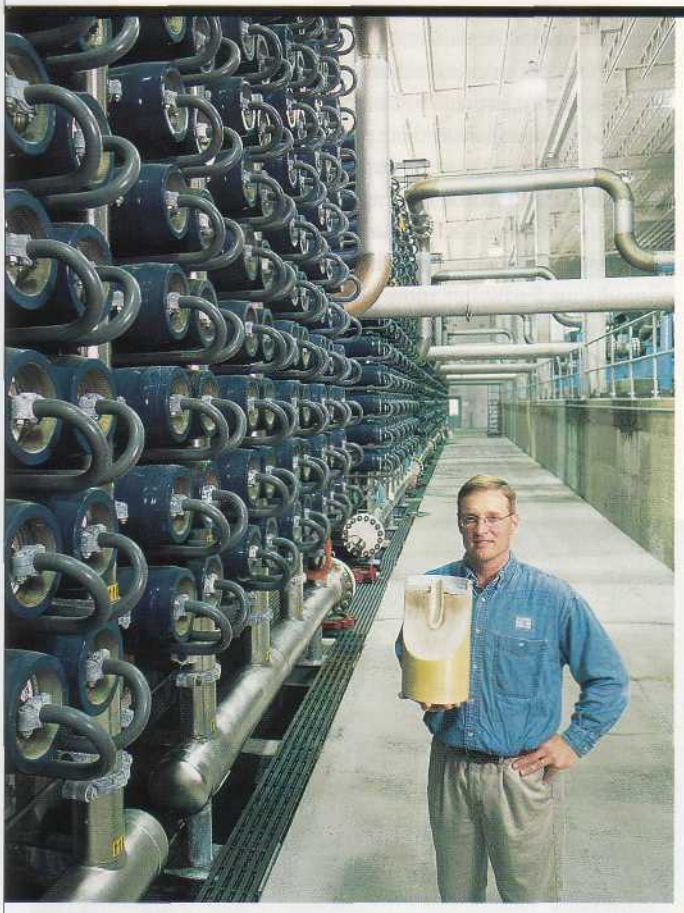
Until very recently, the notion of drinking seawater was lunatic fringe, involving a technology suitable for nuclear submarines and the Middle East, where an oil-rich, water-poor landscape makes financial and practical obstacles irrelevant. In 1960, there were just five desalination plants worldwide. Until the late 1990s, only two American cities had invested in full-fledged desal plants—Key West, Florida, in the 1980s, and Santa Barbara, California, a decade later. Both cities shelved their plans soon after the facilities were built, having found less expensive sources of water elsewhere. It is still cheaper for Key West to pump freshwater 130 miles from beneath the apron of the Everglades than to desalinate seawater.

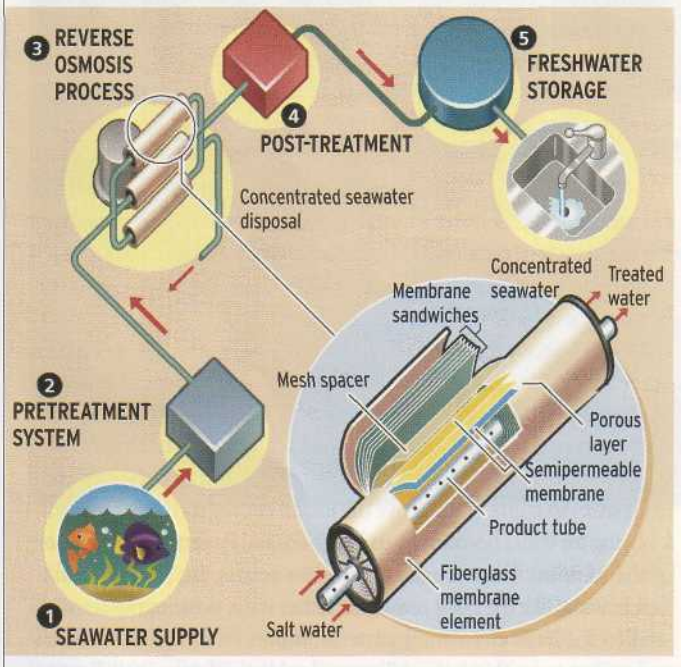
However, as desalination technology improves, lowering the cost of producing freshwater, more planners are looking to the ocean as the droughtproof guarantor of continued growth. Throughout the Sun Belt, metastasizing communities have outstripped existing water supplies and begun to look seaward. Last year, municipal water agencies from California, Arizona, New Mexico, Texas, and Florida pooled resources and formed the U.S. Desalination Coalition, a Washington, D.C.-based advocacy group that lobbies the federal government to invest in new desalination projects.

Today there are more than 12,500 desal plants in 120 countries, mostly in the Middle East and Caribbean. Saudi Arabia meets 70 percent of its water needs by distilling salt water; the British Virgin Islands Tortola and Virgin Gorda rely on desalination for 100 percent and 90 percent of their respective water needs. The American Water Works Association, the largest organization of water professionals in the world—its 4,500 utility members serve 80 percent of America's population—forecasts that the world market for desalinated water will grow by more than $70 billion in the next 20 years.

California will soon be in the vanguard in the United States. It has already planned or proposed about a dozen desal plants along its coast, including a $270 million plant in northern San Diego County slated for completion in 2007. Early last year, the federal government reduced the amount of Colorado River water allocated to Southern California, forcing the state to accelerate its search for alternative sources after years of helping itself to the dun-colored Colorado at the expense of other western states (and Mexico).

To learn about the potential impact of desalination, I visit Mark Luther at the University of South Florida's Marine Science Center, in St. Petersburg. After a slow drive across the Pinellas Peninsula, traffic congealing at every intersection, I pull into the science center parking lot. It's an early December afternoon, hot and dry, the sky blue from seam to seam. High above the lot, an osprey throws a tantrum, lobbying for issues beyond my comprehension. From the second floor of the building I can see the desal plant across the bay on Apollo Beach, white like the salt it removes. Luther is the oceanographer who studied the bay's circulation patterns as part of the environmental assessment team that helped Tampa Bay Water determine where to site the facility. We settle at a black laboratory table in his bright, cluttered office. Luther, 50, wears a powder-blue yacht club T-shirt and sockless moccasins. His eyes match his shirt. His sand-colored, shoulder-length hair hangs in a ponytail. Luther tells me that, on average, 60 cubic meters of freshwater a second flow into the head of Tampa Bay, courtesy of four main rivers—the Hillsborough, the Alafia, the Manatee, the Little Manatee—and a number of smaller tributaries. The freshwater, lighter than salt water, is stirred by the tides before draining into the Gulf of Mexico.





Put simply, desalination purifies water by removing dissolved mineral salts and other solids. In the Middle East, most desalted water is produced by means of distillation, which imitates the natural water cycle: Salt water is heated to produce water vapor, which then condenses to form freshwater. American desal plants favor a different technology—reverse osmosis—which forces the water through a series of membranes, leaving the salts behind. Tampa Bay Water engineer Ken Herd, top, shows a cutaway model of one section of wound membrane. Hollow at its core, each section conveys the desalinated water to the final "post-treatment" phase.

"No matter where you take freshwater, it's going to have some impact on the environment," Luther says. "The goal is to distribute the sources to reduce that impact." Besides operating the desal plant, Tampa Bay Water pumps two new groundwater sites and diverts water from three of the rivers that feed Tampa Bay. "Taking river water has a much larger impact on the bay than the desalination facility," he says. "Of all the ways to get potable freshwater, building a desal plant is no worse and probably better than overpumping well fields or diverting too much river water." It's hardly a ringing endorsement, but it also suggests that an intelligently planned desal plant is not something a sensible environmentalist should lose too much sleep over.

You can't locate a desalination plant just anywhere, however. You need an energy source to operate the plant and a circulation pattern that removes the discharged brine. Brackish water, being less salty than seawater, costs less to desalinate. Hence, the plant was built inside the bay, on Apollo Beach, where salinity, though varying seasonally, averages 20 parts per thousand (ppt), 15 ppt lower than in the Gulf of Mexico. The Big Bend coal-fired power plant sits next door, providing a ready source of water and energy. Of the 1.4 billion gallons the power plant uses each day to cool its condensers, Tampa Bay Water recycles 44 million gallons for desalination. Because the plant already passes intake water through a pair of screens to filter out fish and other sea organisms, from fish eggs to plankton, the desal facility does not cause any additional loss of aquatic life. From the 44 million gallons of salt water it receives daily, the plant produces 25 million gallons of freshwater. The highly concentrated salt water that remains is mixed with the power plant's effluent before being returned to Tampa Bay.

This discharge water adds only marginally to the salinity of the bay, says Luther. A little more than a quarter of a mile from the discharge site he could not detect any increase in salinity. "We're at least an order of magnitude less than natural variability," he reports. The circulating currents and tides, aided by a 43-foot-deep shipping lane dredged decades ago, wash the brine away from Apollo Beach.

Not everyone believes the desal plant is benign. According to an advocacy group called Save Our Bays, Air and Canals (SOBAC), which has its headquarters in Apollo Beach, Tampa Bay takes two years to flush. The briny discharge, SOBAC claims, is equivalent to dumping a truckload of salt in the bay every 16 minutes. The group says that part of the littoral zone off Apollo Beach is already hypersaline. Luther does not believe the desal plant will add to the problem. This part of Tampa Bay flushes about every two weeks during the summer, he tells me, less frequently during the winter. "The waters off Apollo Beach are constantly refreshed. That's why the site was chosen.

"It's ironic that SOBAC brings up hypersalinity;" Luther adds. "Probably the biggest environmental disaster to hit Tampa Bay in the last 50 years was the construction of the Apollo Beach community. They dredged pristine mangroves and sea grass beds to build stagnant finger canals and spits of land that are now heavily developed. All those waterfront homes have nice green sodded lawns that require fertilizers and pesticides, which drain right into Tampa Bay."

As a naturalist, I know that filtering salt from seawater is not a novel idea. For hundreds of millions of years marine plants and animals have evolved unique methods of desalination. Salt glands discharge excess salt through the nostrils of marine iguanas, the eyes of sea turtles, and the tongues of crocodiles. The underside of the leaves of black mangrove trees exude pure salt crystals that

COLIN HAYES

glisten in the tropical sun; the spidery roots of red mangroves block salt from entering the tree. The gills of saltwater bony fish such as tuna or striped bass, the rectal glands of sharks and rays, and the super-kidneys of whales and seals perform a similar function.

I want to understand how desal works for humans, so I drop in on Ken Herd, 43, engineering and projects manager at Tampa Bay Water's Clearwater office complex. Tampa Bay uses a reverse osmosis (R.O.) membrane system, explains Herd, in which salt water is pushed at extreme pressure, up to a thousand pounds per square inch, through tiny pores, each 0.0001 micron in diameter—approximately 1/1,000,000 the width of a human hair.

Osmosis, as you may recall from l0th-grade biology, is the tendency of a fluid to pass through a semipermeable membrane, such as the wall of a living cell, into a solution of higher concentration, to equalize concentrations on both sides of the membrane. Reverse osmosis is precisely... the reverse. The pores of the roughly 10,000 tightly rolled membranes are so small that ultratiny molecules of water pass through, but larger molecules of dissolved minerals like salt do not. Pressure forces out the salt, and the constant flow of water helps wash the outer membranes clean of concentrations of brine. R.O. membranes still clog, however, and have to be cleaned, every three weeks to six months or longer. The membranes last five to seven years, sometimes ten, and they are expensive to replace.

Eleven well fields and four inflowing rivers have not been enough to meet the demands of Tampa Bay's mushrooming urban population.

Herd shows me a model of a three-foot section of wound membrane. It looks like an oversize roll of paper towels, with the top cut away so that I can see inside. Salt water forced against the outside of the roll filters through the spiral until pure freshwater flows into the center port—the equivalent of the cardboard tube inside the roll of paper towels—and then out into a network of collecting pipes. The total surface area of the plant's 38-inch-wide membranes would cover nearly 65 football fields.

"However," says Herd, "R.O. is the simplest part." First, the bay water must be treated before it's forced across the R.O. membranes. Pretreatment filters out suspended solids—such as scraps of seaweed, fish fry, aquatic larvae, sundry items of flotsam and jetsam. If this weren't done, the membranes would foul. "Pretreatment," says Herd, "is the challenging phase of desalination." Tampa Bay Water uses dual-stage sand filtration, in which incoming salt water flows up through two filtration cells, coarse- and fine-grained. Particulate matter larger than five microns in diameter that manages to pass through the sand filters gets caught in the cartridge filter—a collection of long, thin filters, like those used in swimming pools, which act as the R.O. membranes' safety net.

In every performance test, both the pretreatment filters and the R.O. membranes clogged more frequently than expected, requiring additi additional cleaning. Increasing the strength of the cleaning solution for the membranes caused another unforeseen problem: Two million gallons of caustic, soapy cleaning fluid had to be transported to Tampa's wastewater treatment plant.

Asian green mussels turned out to be the culprit. The alien shellfish first appeared in Tampa Bay about eight years ago, having been transported in the ballast of tankers, and has thrived. Mussels love flowing, food-rich water, so the power plant's daily l.4 billion gallons of effluent is bivalve Utopia. Larvae pass through the power plant's intake screens, survive in the heated water, then clog the pretreatment filters, fouling the R.O. membranes with microscopic hairs.

The post-treatment phase also has its complications. Along with salt, alkaloids are stripped out of the water, leaving the desalinated water acidic and corrosive to pipes. So calcium carbonate (lime) is added during post-treatment, raising the pH level before the water is piped 14 miles to storage. All this trouble and delay has resulted in lost time and money. The desal plant has declared bankruptcy three times, most recently in October 2003. The plant is online only once a month, and Tampa Bay Water says it will not go into full production until 2006.

Contemplating the sprawl that surrounds the Apollo Beach plant, I find myself paraphrasing the line from the Shoeless Joe Jackson character in the movie *Field of Dreams: "If* you build it, they will come." Herd bristles a little at the phrase. "The government agency that allows growth supports its decision with electricity, drinking water, and waste removal. The water management district doesn't have the ability to limit growth; that's the job of the planning board. Tampa Bay Water just supports the growth that's already there."

Tampa Bay Water admittedly has taken significant steps to diversify its sources of potable water, and to do so in an environmentally responsible way. As of April 2004, the water authority was pumping only 74 million gallons a day from the ailing well fields, in hopes of restoring that corner of the Floridan Aquifer. As a result of these reductions, the surrounding wetlands have begun to recover—lake levels are rising and marshland vegetation is looking fuller, more lush, a de Soto shade of green. "We didn't trade one environmental impact for another in Pasco County by shifting the burden to Tampa Bay," Herd says with justifiable pride.

Herd's optimism is refreshing. And he's right: It is not ultimately the water authority that determines the carrying capacity of a suburban landscape. Many of the 20 commercial seawater desalination projects under consideration for the Sun Belt are driven by planners who both forecast and encourage growth, often in ecologically sensitive coastal areas. Faced with lobbying by the U.S. Desalination Coalition, environmentalists will need to scrutinize each new project. For if new desal facilities mean that the wild hills become crowded with condos and the shorelines fill with sprawl, we may find ourselves echoing another line that's associated with the hero-turned-villain of the 1919 Black Sox scandal. We'll have built it, they'll have come, and like the distraught young fan, we'll be exclaiming, "Say it ain't so, Joe."