The Economics of Water

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Robert Malthus, famed economist and demographer, proclaimed in a series of published works beginning in 1798 that projected population growth would ultimately prove unsustainable. One principal element to his theory was that the Earth's limited natural resources could not support an expansive population. But Malthus died in 1834 and his ominous prognostications have yet to materialize, mostly due to continued human ingenuity and innovation. However, the world's inhabitants have expanded from one to seven billion, a profound surge that might well lead to unintended and unpleasant consequences as a result of increasing demand for limited natural resources.

Fresh water, perhaps the most basic, fundamental and indispensable of human needs, is not immune to the changing global landscape. While it is a renewable natural resource, its supply has been steadily decreasing but with scant notice. Rather, discussion and debate is predominantly on fossil fuels. This may be the case because, unlike oil, water prices rarely respond to the forces of supply and demand thus creating the impression that all is well. It is not.

Several factors may help to explain this paradox. The water supply system in the developed world is mostly invisible; its pipes are underground. Clean drinking water is perceived to be abundant and cheap. It is always there and its price is generally unrelated to usage. Most people consider access to be a right; large price increases and/or restrictions on consumption would not be tolerated. As a result, water is a bargain. The average water and sewer bill for a U.S. citizen is roughly $40 per month, about half that of a cable TV bill. Curiously, despite the fact that tap water is subject to more regulatory scrutiny than the bottled alternative, U.S. consumers spend $21 billion annually on bottled water and just $29 billion maintaining our largely hidden water infrastructure. Tap water costs less than one cent per gallon, a tiny fraction of an equivalent amount of gasoline. While fresh water is a necessity that lacks substitutes, its pricing structure indicates otherwise.

Water has stresses on both the supply and demand sides of the ledger. Its supply is dwindling and some locations such as the critical Ogallala Aquifer, which is located beneath the Great Plains in the United States and provides 30 percent of the nation's irrigation groundwater, are being unsustainably drained. This supply reduction has been occurring for years, effectively "mining" our nation's water reserves. Demand is escalating with both the absolute increase in population and the relative increase in consumption per person. The solutions, whether conservation-oriented (e.g., improving infrastructure to arrest leaks and waste) or supply-oriented (building desalinization plants) will be exceptionally expensive.

We obviously cannot live without water, yet its value is a paradox. When viewed in isolation, one might intuitively surmise that a necessity is more valuable than a nonessential item such as a diamond, for example. Diamonds serve no basic human need but command a much greater price than a similar quantity of water. No one disputes that water serves more total utility than diamonds, but water has less marginal utility. In other words, diamonds derive scarcity value unlike water which is perceived to be unlimited and abundant. This paper will address the fundamentals of water, its apparent defiance of the laws of supply and demand and the potential investment opportunities that exist.

Supply

The supply of water has been relatively constant since the beginning of time. In a simplistic sense, it follows a closed-loop pattern, falling to the Earth's surface and then vaporizing back into the atmosphere. Water cannot be manufactured in a cost-effective manner, at least not yet. Its molecular structure proves quite deceptive in that water contains both hydrogen, which is highly flammable and oxygen, which supports combustion. Given these physical characteristics, the process of joining these two to produce drinkable water is economically untenable at this point in time.

Despite covering 70 percent of the Earth's surface, water suitable for human use is still a scarcity, as difficult as that may be to comprehend. Conventional wisdom typically overstates its supply. Only 2.5 percent of the Earth's water is deemed fresh, the only kind fit for direct human consumption. In addition, most fresh water is prohibitively difficult to access as it is frozen in the form of glaciers or ice caps, in the air as vapor, buried underground in aquifers or in the body of plants and soil. Just 0.3 percent or less of total fresh water is in liquid form on the Earth's surface.
Potable, or drinking, water represents an even smaller portion, only 0.007 percent.\textsuperscript{6} From this data, the perception of an unlimited water supply is clearly flawed.

### World Water Supply

- Fresh Water: 2.5%
- Salt Water: 97.5%

### Fresh Water Supply

- Potable: 0.3%
- Liquid Form: 11.7%
- Difficult to Access: 88.0%

Usage can also exacerbate the issues with water supply. In the U.S., total daily water consumption averages 98 gallons per person according to the latest U.S. Geological Survey, well in excess of other developed countries. Alarmingly, the states with the highest consumption rates are in the driest regions of the U.S. which are projected to experience the most rapid population growth in the near future. Clearly a large portion of this is going to lawns and golf courses.

While water issues have typically been considered to be a “developing” versus a “developed” world problem, we may be at a Malthusian tipping point wherein that is no longer the case. As an example, Australia suffered from the “Big Dry,” the nickname bestowed on the decade-long drought that ravaged the Murray-Darling river basin and was proclaimed to be the worst in a thousand years.\textsuperscript{9} This economically critical reservoir provides three-quarters of Australia’s water needs. The consequent effect of the water shortages on commerce and broader economic health was profound, as Australia’s citizens learned firsthand. In 2008, the rice industry was devastated with only 18,000 tons of the water-intensive grain harvested, compared with one million tons annually in the past. All told, the Big Dry reduced Gross Domestic Product by about one percent for several years and propelled the cost of water from $25 (Australian) per million liters to a record $1,200 in 2009, just over the course of a few years.\textsuperscript{10} It also exacted a social toll as higher levels of unemployment bred increased crime in many towns.\textsuperscript{11}

Australia has not been alone confronting this natural catastrophe. Cities such as Barcelona and Atlanta have also faced serious water shortages in the recent past. While wide-scale economic calamity was averted in these developed country examples, cracks in the supply foundation have been exposed.

### Demand

The assumption that bathing, drinking and cleaning activities account for the bulk of water demand is mistaken as shown in the table on page 3. Agriculture accounts for 70 percent of water withdrawals, followed by industry with 20 percent and domestic (urban) with 10 percent. In a way, water demand goes largely unnoticed as drinking and showering represents just a small fraction of actual withdrawals. By contrast, it takes 1,000 liters of water to produce one liter of milk and 21,000 liters for a kilogram of roasted coffee. On the industrial side, 16,000 liters of water is consumed in the production of a single kilogram of microchips.\textsuperscript{12, 13} Clearly, bringing transparency and efficiency to the heavy agricultural and industrial usage of water will help shape its future.

Demand for water has obviously risen as a result of global population growth. This will surely continue given the United Nations’ projection of 30 percent additional inhabitants by 2030.\textsuperscript{14} It takes a lot to feed the roughly seven
billion people on the planet which explains why agriculture is by far the largest consumer of fresh water. Furthermore, dietary changes will continue to have a significant impact on demand. Water usage skyrockets as people shift from grain-based to protein-based food products as noted in the previous milk example.

Another force behind increased water demand is the improved quality of life in many developing countries, driven by per capita income gains as people enter the middle class. Even seemingly modest enhancements in one’s standard of living can have a multiplier effect on water usage. To illustrate, 95 percent of the water that utilities provide to residential customers is not for drinking or cooking but rather for flushing toilets, filling bathtubs or pools, washing cars and watering lawns. Luxuries only add to the water usage tally; a typical golf course utilizes about 45 million gallons of irrigated water annually.17 To illustrate the complexities of this issue, golf course water will seep into the ground and thus eventually be reused. Fracking water, however, becomes polluted, effectively ending its useful life. In short, new technologies can represent new stresses to the demand side of the water ledger that did not exist 100 years ago.

The combination of population growth, lifestyle improvements (especially in the middle class) and technology needs is expected to lead to significant new water demands in excess of any currently anticipated efficiency gains. By 2030, global water demand is expected to rise an estimated 53 percent.18 With near certainty, the developing world, already wrestling with water scarcity, will be acutely impacted by the enormity of future water-related challenges.

Cubic kilometers per year unless otherwise indicated.

<table>
<thead>
<tr>
<th>Region</th>
<th>Renewable Water Resources</th>
<th>Total Water Withdrawals</th>
<th>Agriculture</th>
<th>Industry</th>
<th>Domestic (Urban)</th>
<th>Withdrawals as a Percent of Renewable Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>Percent</td>
<td>Amount</td>
<td>Percent</td>
<td>Amount</td>
<td>Percent</td>
</tr>
<tr>
<td>Africa</td>
<td>3,936</td>
<td>217</td>
<td>186</td>
<td>86</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Asia</td>
<td>11,594</td>
<td>2,378</td>
<td>1,936</td>
<td>81</td>
<td>270</td>
<td>11</td>
</tr>
<tr>
<td>Latin America</td>
<td>13,477</td>
<td>252</td>
<td>178</td>
<td>71</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Caribbean</td>
<td>93</td>
<td>13</td>
<td>9</td>
<td>69</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>North America</td>
<td>6,253</td>
<td>525</td>
<td>203</td>
<td>39</td>
<td>252</td>
<td>48</td>
</tr>
<tr>
<td>Oceania</td>
<td>1,703</td>
<td>26</td>
<td>18</td>
<td>73</td>
<td>3</td>
<td>12</td>
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<td>418</td>
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<td>32</td>
<td>223</td>
<td>53</td>
</tr>
<tr>
<td>World</td>
<td>43,659</td>
<td>3,829</td>
<td>2,662</td>
<td>70</td>
<td>784</td>
<td>20</td>
</tr>
</tbody>
</table>

Technological advancements can be both a blessing and a curse for water demand. On the positive side, improved industrial processes, leak mitigation and water conservation can serve to moderate gloomy forecasts of water usage. The negatives, however, are formidable. Cell phones and computers impact consumption as water is needed to manufacture microchips. Additionally, hydraulic fracturing (“fracking”) and horizontal drilling have transformed the natural gas industry but, unfortunately, they require considerable amounts of water. It is estimated that five million gallons is needed to drill and fracture a typical deep shale gas well, roughly what New York City consumes in seven minutes, actually rather small when compared to golf courses.17 To illustrate the complexities of this issue, golf course water will seep into the ground and thus eventually be reused. Fracking water, however, becomes polluted, effectively ending its useful life. In short, new technologies can represent new stresses to the demand side of the water ledger that did not exist 100 years ago.

<table>
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<tr>
<th>World Population Estimate Milestones (U.S. Census Bureau)</th>
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<tr>
<td>Population (in billions)</td>
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<tr>
<td>Years Elapsed</td>
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</table>

The Economics of Water  3
The Future
To understand what lies ahead for water, it is instructive to examine the past. Throughout history and long before Malthus, there are many examples of economic successes attributed to harnessing water power. The ancient Greeks’ transformation of the Mediterranean Sea into a means of maritime commerce and James Watt’s invention of the steam engine are just two cases where water served as an economic fulcrum.

Water will continue to play a pivotal role in the attainment of economic growth. To assure its availability in adequate quantities, the problems cited in this paper must be addressed, in large part with supply-enhancing technologies and demand-reducing practices. Somewhat encouragingly, a new water reality may already be emerging. In the U.S., less water is used today than in 1980, even though the economy has doubled in size. This has been accomplished through efficiencies in power plants and farms that suppressed demand, along with the outsourcing of water-intensive industries which only transferred the problem elsewhere. On the corporate side, General Electric, which has a dedicated water business, tracks its own water consumption and experienced a 22 percent reduction between 2006 and 2010. Intel has invested over $100 million in conservation programs since 1998, displaying a new mentality toward this natural resource. These are but a couple of examples of corporations finding ways to improve revenues and shed expenses by thinking differently about water.

One part of the solution is that the current pricing structure needs to be changed, complete with a transition to higher prices and a volume-oriented pricing component. The lack of appropriate pricing is consistently cited by players on all sides of the industry as the largest obstacle to solving impending water issues. Going forward, economic disincentives for high usage need to be implemented to encourage conservation and help raise awareness to the challenges that lie ahead. Some pricing policies have been introduced in certain parts of the U.S. but have not been universally adopted. In some cases, higher prices have actually led to decreased usage. In addition to ushering in accountability for water use, a revised pricing structure should attract capital for investment along with providing suppliers like utilities with higher revenues to fund water infrastructure spending.

Difficult discussions will need to take place regarding water allotments as well. Conversations must extend beyond enhanced scrutiny over golf courses in arid corners of the country. A more taxing dialogue surrounding U.S. agriculture will be essential since it is the largest consumer of water yet contributes a meager 1-2 percent of overall GDP. To illustrate one important part of its impact: some farm products such as soybeans consume large volumes of cheap water in their production process. When they are sold abroad, the U.S. is effectively exporting “virtual” water, that which is involved in the growing and manufacturing of traded goods, and permanently depleting our nation’s natural water supply. Debates focusing on the scarcity of natural resources are nothing new. M. King Hubbert direly predicted that oil production would peak in the continental U.S. in the 1970s but the U.S. economy has, for the most part, continued to grow despite oil’s domestic decline. As the new oil reality set in, the economy began to adapt. Fuel mileage standards were imposed and hybrid vehicles were introduced. It is highly probable that the future of water will follow a similar path. Already, innovators and entrepreneurs have entered the fray, raising expectations that exciting technological and investment opportunities will present themselves in the years ahead. For the time being, it is abundantly clear that solving the challenges facing water has political, economic and societal implications.

Investment Challenges and Opportunities
Investors who seek opportunities in the water “industry” will find it a challenging landscape to navigate. Water is mispriced and until that is corrected, many of those investors will largely remain on the sidelines. Nevertheless, narrowing drinking water’s supply-demand relationship will eventually offer tremendous opportunities; an estimated $500 billion will be needed for infrastructure over the next 20 years just to replace decaying water and sewer systems. Notably, this vast amount of capital only covers what is needed to maintain the status quo, essentially ignoring additional future improvements such as smart metering (to encourage conservation and leak detection) or new filtering technologies.

In the following sections, we discuss both public and private investments in water and their related risks and benefits.

The Public Sector
There are a number of investment options in public companies. For example, equities are available in water and public utilities either directly or via Exchange Traded Funds (ETFs). Water companies are decidedly eclectic but can be broadly separated into water distribution and water products. The distribution segment is primarily made up of utilities that typically distribute drinking water and collect sewage and are significant purchasers of piping, pumping and filtration systems. It also includes bottled water companies and industrial businesses such as those involved in trucking water for fracking operations.

Water product companies tend to be industrial manufacturing enterprises that produce treatment equipment, pipes, valves, tubes and other critical infrastructure components, or related service firms such as engineers and consultants. In contrast, technology companies provide products predominantly for filtering or leak detection.
A dilemma exists for the investor who is forced to choose between large, well-seasoned companies whose water businesses account for only a small fraction of total revenues, or very small, high-risk alternatives. To illustrate the first option, General Electric’s water-related revenues, while sizeable in absolute terms, account for only two percent of its total business. By the same token, bottled water companies are almost all owned by large food conglomerates. Large companies, therefore, give the investor little actual exposure to the water industry.

There are several water-oriented ETFs, two of which are currently on the Abbot Downing platform. Potential investors must recognize that due to the small size of the universe and the companies therein (typically the small and unseasoned), these instruments tend to suffer from low trading volume and potentially constrained liquidity, and can be concentrated and volatile. In short, buying and selling large blocks of these ETFs can be costly and difficult to transact, especially during times of enhanced market volatility.

Investors can also choose other publicly traded alternatives including the corporate debt of water companies or municipal bonds that finance water projects. However, there does not appear to be institutional quality, commingled water debt funds. Most public utilities tend to be monopolies with predictable revenue streams but are regulated and suffer from limits on profitability. Another possibility exists in indirect plays such as agriculture futures but these incorporate significant risks. Unfortunately, there is no futures market for water, primarily due to the considerable transportation and storage costs needed to take physical delivery.

**Private Solutions**

Private opportunities in the water space include water rights, venture capital plays, hedge funds and infrastructure funds, among others. Private structures allow for extended holding periods and are well suited to the types of investments that take longer to mature. Some of these are equity funds while others are real asset plays, but overall they would be included in the Abbot Downing complementary strategies allocation. Since this is a nascent sector, few if any managers have built and subsequently liquidated a fund. Consequently, investments in this category carry formidable risks associated with first-time managers.

**Water Rights**

In the western U.S. and Australia, water rights are akin to mineral rights and may be detached from land and sold separately. These are perhaps the most pure water plays available. In the U.S., water rights are perpetual and a perpetual legal right to extract a fixed amount from a defined basin for beneficial use. They are structured as “use it or lose it” rights so the water cannot simply be stockpiled long term. As with different seniorities of debt instruments, there are different levels of water rights.

Specialized managers are now employing private equity style fund structures to target water rights and water-rich agricultural land. Some use a long-term buy-and-hold strategy with no catalysts for increases in value, which is not of interest to us. Others work to profit from buying rights at their agricultural value and selling them for more valuable uses such as for drinking, and industrial and energy production. Typical risks of these strategies include overpaying, the absence of competing end-users to unlock additional value or the rights lack seniority. Managers clearly must have deep knowledge of the water rights landscape, including the myriad regulations and players.

**Venture Capital Funds**

This is the investment option in which transformative technologies may be developed and ultimately commercialized. Stand-alone water-oriented venture funds are rare. “Cleantech” funds, those catering to environmentally friendly businesses, typically have only a small allocation to water-related themes and are usually energy-oriented. There are also several large, more mainline venture firms that invest in the space but water has represented just a tiny fraction of the overall invested amount over the last decade. Companies that were funded tend to produce filtering, leak detection or monitoring systems.

A potential bright spot for venture capital funds may be the oil and gas industry’s need for effective water filtering technology as part of the fracking process. The funds seek to mitigate both the substantial water usage per well and its associated trucking traffic, and to quell public pressure to properly dispose of the residual polluted water, most of which can hopefully be solved through improved filtering. This is but one example of the industrial needs that will drive commercialization in the water segment, thus boosting revenue prospects for venture-backed companies and ultimately for venture capital funds.

**Hedge Funds**

Hedge funds focusing on water are rare but more frequently available than their venture fund counterparts. As in the case of public equity managers, hedge funds must contend with the same limited investment universe. Since many available companies are small, shorting them can be expensive, thus increasing transaction costs and detracting from returns. On the plus side, hedge funds, unlike other private investments, usually allow quarterly liquidity thus providing investors access to water-related businesses without being committed for multiple years.

**Infrastructure Funds**

These funds may own water assets such as desalination plants or water distribution networks but typically focus on ports, pipelines and airports. Desalination plants have historically been expensive, use large amounts of energy and, at least in the U.S., face stiff regulatory hurdles similar to large, unwieldy building projects. Infrastructure funds
in general tend to have very high investment requirements and are heavily leveraged; we are not aware of any purely water-focused entities.

Summary and Conclusion

Unfortunately, there is impaired vision when it comes to the economics of water. Many, if not most, users of this critical natural resource are not aware of or acknowledge the inevitability of shortages, do not notice the impact of pollution on supplies and are oblivious to the fact that future prices will be dramatically influenced by these and other factors. Yet, there are realists who are well aware of their water footprint and are intent on making changes. (Benjamin Franklin may have been in that group, stating that “When the well is dry, we learn the worth of water.”) History shows that unleashing human ingenuity and innovation can overcome and solve seemingly insurmountable challenges.

As noted in this paper, investment opportunities exist in water, although limited in scope. Before considering them, perhaps the investor should first decide whether water-related options are simply a means to make money or, at the risk of being hyperbolic, to save the world. This may be the only asset class wherein those two options might exist; we maintain that it is possible to do both. As an example, water-oriented venture capital funds have the capacity to back companies whose technologies could address the global concerns discussed herein. Large-scale improvements to filtering and desalinization, to name only two, would go a long way toward solving seemingly intractable problems.

We have presented other investment vehicles in the water space that unfortunately come with formidable obstacles, most notably the limited number of choices currently available. Both public and private options exist, each with their own list of positives and negatives, especially in the short run. Furthermore, investors may be deterred by the absence of supply/demand-related price rationality, understandably concluding that investment success will be predicated on rising prices. Nonetheless, given the vast long-term potential, we will continue to research and monitor the progress of new and existing funds and managers as well as the technology that will inevitably flow from the challenges that lie ahead. We are now only in the early days of this pre-emerging asset class.
Endnotes

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24 Reuters, December 2012 – Looking for Gold in Water Investments
25 China’s Water Nexus: August 3, 2011
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