ON MATTERS THAT MATTER

From Trend to Opportunity – Water Resources and Reclamation

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An Occasional Essay on Matters that Matter

From Trend to Opportunity: Water Resources and Reclamation

As private equity investors in selected environmental markets in the United States and Canada, NewWorld Capital Group publishes occasional essays on matters that matter in our investment strategy. We seek to present an analysis of the forces at work that are shaping investment opportunities and risks in our target markets and in the broader environmental opportunities sector.

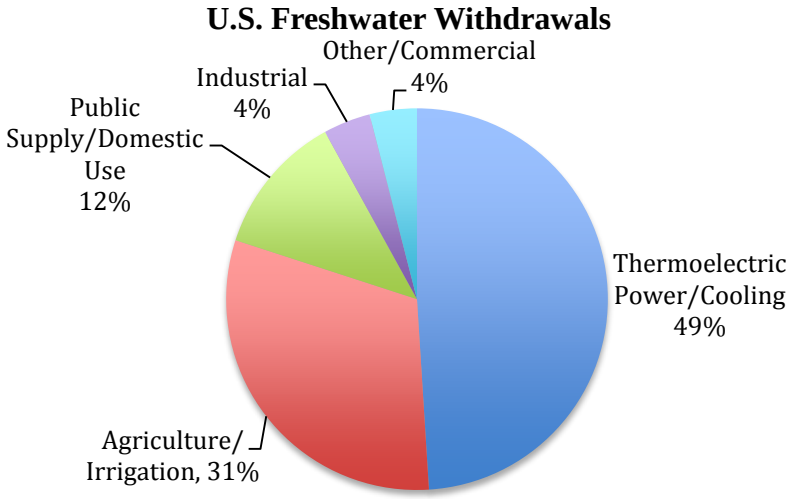
The days of using freshwater indiscriminately, or water treated to potable as the standard for use, are changing in the U.S. The paradigm is shifting to "reduce, reuse and recycle," working to match the quality of water to the most appropriate uses. NewWorld believes this shift is producing interesting possibilities for growth investments and infrastructure investments around distributed reuse of water and water recycling products and services, where a cost-effective amount of treatment can deliver significant value by extending water lifecycles, although the field is still early and in development.

While "scarcity" is the term usually used to discuss what will drive much of the decision-making around water in the coming years, NewWorld prefers "access to water" as more accurate. Earth's water cycle is a closed loop. When people refer to scarcity, the reference is typically to fresh or potable water. While there are many instances where fresh and potable water usage can and should be reduced, there are also many cases in which non-potable water can be replaced by gray or brackish water. For example, reusing graywater for irrigation, instead of tap water treated for direct human consumption, or using saltwater for hydraulic fracking instead of aquifer water represents treatment appropriate to particular applications where cost and quality are matched to use.

A bigger question relating to competing interests for water access is whether the market provides the appropriate tools for making allocation choices concerning water. Right now, different interests (such as farmers vs. industry) typically compete on an inefficient, piecemeal basis—mostly driven by the market with an overlay of patchwork regulation—and little to no thoughtful, systemic consideration of the larger societal issues and values (such as prioritization of water access and land use) guiding decision-making. For example, a free market might deliver all or most of the water supply from a given source to a high-paying municipality, rather than to agriculture.

Amid this complexity, NewWorld views its role more narrowly through the prism of identifying and supporting companies that can make a profit by providing products and services that help businesses more efficiently use and reuse their water resources.

Below is an overview of major trends affecting the U.S. water market, followed by end-use segment deeper dives in which we explore the opportunities and investment implications for potable water and wastewater use and reuse respective to their applications in energy, agricultural, municipal/residential, industrial, and commercial markets.[1]



Trends Affecting the Water Market

Trends impacting the water market include demographic growth and movement, infrastructure challenges, climate change, government policy failures, accessing additional water sources, allocation among competing uses, and "treating to purpose rather than to potable," among others.

Demographics

Demand for water in the United States from energy, agriculture, municipalities/residential, industry and commercial end-users is increasing as population grows. Since 1950, the U.S. population grew 99% with total water withdrawals increasing 127%[2]. Looking forward, an additional 100 million people are expected to be living in the U.S. by 2060, bringing the estimated population then to roughly 410 million people.

[1] These segments and chart were created based on USGS data for measuring freshwater withdrawals. The last data collected was from 2005 but the ratios are approximately the same today. The next results are expected to be published by yearend 2014.
[2] Columbia University Water Center

Moving patterns among the U.S. population over the past decade to states including Nevada, Texas, Georgia, and North Carolina has placed particular strains on water resources in the U.S. in certain areas that are less "water rich," with rippling effects out to their larger regions.

In addition to increased consumption of energy and water directly, larger populations correspondingly require more food, with water being essential for food production.

Infrastructure Strains

At a time when demographic growth requires increased infrastructure to supply demand, aging water infrastructure in the U.S. also creates water challenges as leakage from older systems wastes large volumes of this resource at a substantial cost to cities and municipalities. U.S. drinking water infrastructure is 100 years old on average and has been showing signs of aging: an estimated 240,000 water main breaks occur each year.[3]

According to the U.S. EPA Clean Water and Drinking Water Infrastructure Gap Analysis Report of 2002 (the most recent report available on the subject), over half the pipework of the U.S. water supply system will be in poor condition or worse by 2020, compared to 10% in 1980, while the number of excellent pipe systems will have declined from 68% to 32%.

Most of this infrastructure was originally built in the early 20th century, and enormous investments are needed for repair and upgrade. Spending for this, however, has lagged such that, at current levels, the funding gap between what is needed and what will be spent for maintenance of drinking water and wastewater treatment facilities over the next 20 years is estimated at approximately $400 billion (not including the infrastructure upgrades needed for wastewater and stormwater restoration systems).[4]

Climate Change

More frequent and extreme climate disruptions further exacerbate the stress on water resources.

2013 has been the driest year in the U.S. on record with more frequent and severe droughts leading to faster-than-expected water depletion rates due to increasing energy use (air conditioning), increasing irrigation use (to maintain plant health and compensate for evaporation), and increasing municipal depletion from reservoir evaporation.[5] Drought covered 61% of the nation from late 2012 to early 2013, with rainfall as little as 10% of normal. By May 2013, over 90% of America's High Plains were abnormally dry

[3] American Society of Civil Engineers
[4] EPA; American Society of Civil Engineers
[5] Evaporation alone drew 100 inches of reservoir water in one 2011 Texas town due to drought. National Geographic

or in drought.[6] Hydroelectric dams along the Colorado River experienced a 16% reduction in output over the past decade as a result of drought.[7]

In the opposite case, the U.S. has also seen abnormally severe storms and flooding in certain parts of the country.[8] Harsh flooding and severe storms contaminate freshwater reserves by washing in sediments and runoff. Additionally, many municipalities have combined sewage and stormwater infrastructure that overflow with large quantities of stormwater. This typically overwhelms water treatment infrastructure, sending untreated sewage into nearby waterways.

Some regions of the U.S., such as the West, are being hit harder than others by high temperatures, flooding as mountain ice melts earlier in the season, and dry summer months. The extreme weather also strikes unpredictably, making it challenging to plan appropriate responses.

Government Policy Failures

Federal regulatory responses to water challenges have generally been inadequate.

The Clean Water Act lacks comprehensive reforms necessary for today's water quality and scarcity issues, though amendments are being considered. Since 1972, the U.S. has made progress in cleaning waterways but still half of the nation's rivers and streams, one third of lakes and ponds, and two-thirds of bays and estuaries do not meet Federal water quality standards.[9] Many of the gains in water quality have been a result of controlling industrial pipes and discharge waste, but other nonpoint sources such as agricultural runoff, flowback and produced water from hydraulic fracking, and personal care products being discharged into municipal systems (*e.g.*, pharmaceuticals) remain unregulated.

Some proposals being considered now by the EPA include water quality standards for nutrient pollution, power plant cooling standards that would mandate closed-cycle cooling systems, and wastewater regulation for municipalities to manage stormwater runoff more sustainably. EPA's "green infrastructure" push addressing the issue of stormwater runoff has created a big opportunity, but one limited to that specific vertical. There has also been some success at the local level (*e.g.*, NYC's Resiliency Task Force following Hurricane Sandy), although piecemeal and responsive rather than systemic and pro-active. The issues of water have been affected by the political dynamics that do not foster meaningful communication except for a brief period after extreme environmental events.

[6] National Weather Service Data
[7] 13D Research
[8] The last decade has seen many of history's largest natural disasters including the deadliest tsunami in history, the most powerful tropical cyclone ever to make landfall, the largest hurricane in the Atlantic (Sandy), the most powerful earthquake to hit Japan, the deadliest earthquake to hit Haiti, one of the most destructive earthquakes to hit China, the worst drought since the 1930s in the U.S. High Plains (and China and Mongolia's dust bowl conditions), followed by flooding in Colorado, and the deadliest heat wave on record in Europe in 2003. 13D Research
[9] EPA

For certain limited applications, policies that have been codified and are now difficult to change, such as the regulation prohibiting once-through cooling as not environmental, could be modified or eased. Once-through cooling has the advantage of discharging roughly the same amount of water placed into the system, but it has not historically been reused or treated to address the problems that have prohibited reuse, such as harm to fish and river ecosystems, or to take advantage of using water treated to a less than potable standard such as graywater. In many cases, if implemented carefully, once-through cooling could be designed to use gravity as its energy source, to effectively use non-potable water resources, maintain river ecosystems, and to not interfere with fish migration routes. In these ways, once-through cooling could be as environmental as other hybrid energy cooling technologies that require excessive energy to operate.

There is little precedent to outline water rights in regions of water scarcity where rivers, lakes and aquifers cross state and national boundaries. The standing claims are private, usually based on outdated treaties or subject to differing regional and state water laws, coupled with various regulatory agencies. Conflicts between stakeholders have already led to lawsuits between states and towns running dry. As private Oil and Gas (O&G) companies use large amounts of well-water, municipalities and local farmers could certainly benefit from Federal guidelines that might ration municipal water use, encourage water and energy efficiency, and prioritize agricultural uses (for specific high-yield, low water intensive crops) over certain industrial and commercial uses.

For example, Texas, New Mexico, and Mexico are in conflict over water rights along the Rio Grande, while cities and states bordering Lake Michigan argue for access to Lake resources to supplement declining river water levels. It is not yet clear how to resolve these conflicts because of the complexity of competing demands between borders, upstream vs. downstream users, surface water vs. aquifer rights, and how to determine which needs are most important.

In some places, however, communities and states are stepping in. Significant water policy is beginning to appear in the most water-stressed states. Oklahoma's stated goal is to use no more water in 2060 than it does today, while Texas has allocated $2 billion to a public water infrastructure fund, with 20% of funds earmarked for conservation or reuse projects.[10] In one Texas town, municipalities are already rationing water but the cause of depletion (fracking) remains unchecked.[11] These are examples of cases where some kind of national prioritization would be additive.

Accessing Additional Sources

As traditional water supplies are depleted, "new" sources of usable water are being sought, primarily through desalination of seawater, deploying brackish water to replace freshwater in some applications, and treating and reusing wastewater and stormwater runoff. Municipalities and corporations (such as Coca Cola) are seeking solutions and

[10] National Geographic
[11] The Guardian

finding ways to be more efficient—thus the beginning of the shift to the paradigm to "reduce, reuse and recycle" and match the quality of water with its use.

Balancing Competing Demands

Wide-ranging end uses, such as agriculture, energy production, municipal use (drinking and recreation), and ecosystem needs, have begun to compete for the water resources in water-scarce regions like the U.S. Southwest. Our society also does not yet appreciate behaviorally that water is energy, water is integral to food supply, and water is integral to recreation and the environment more broadly—and that real choices are going to have to be made.

As an example, there are approximately 30 communities across Texas that are likely to run out of water within the coming months. One of these towns is Barnhart, where nearly 15 million people are living under some form of water rationing, barred from freely sprinkling their lawns or refilling their swimming pools. In Barnhart's case, the well appears to have run dry because the water was extracted for shale gas fracking.[12] What is lacking is a societal consensus on how to prioritize uses and allocate water. How these choices are ultimately determined will involve a combination of legal actions, legislation, regulation and political haggling, which will ultimately be a test of the true social contract in our country.

Treating to Purpose, Not to Potable

As demand for potable water is increasingly placing strains on the U.S. water supply, we are in the midst of a gradual shift from expensive overtreatment of water to potable standards in most cases, to matching the quality of water with its ultimate use.

End-Use Segment Deeper Dives/Investment Opportunities

Looking more closely at the end-use market segments of energy, agriculture, municipal/residential, industrial, and commercial, there are a number of investment implications and opportunities for potable water and wastewater use and reuse.

Many of these opportunities may be slow to be realized due to the need for asset intensive capital and to the time needed for adoption of new behaviors, standards and technologies to replace the collective practices of overusing freshwater and/or over-treating water for its purpose. NewWorld will continue to seek asset-light and sustainably-differentiated business investments that reduce water consumption and allow for recycling opportunities in niche plays and could be near-term takeouts for large water companies and/or other strategic buyers.

[12] The Guardian

Energy

The Water-Energy Nexus[13] may be the limiting factor in power availability and an important driver of the transition to renewable fuels. Power plants (including coal and nuclear) account for nearly 50% of all freshwater withdrawals annually in the United States. Growing populations in the U.S. and the nation's growing economy will require 393,000 MW of new generating capacity by the year 2020 (nearly a 40% increase of current capacity), not including additional water needed for increased food demand, further increasing the strain on water resources.[14] The U.S. Energy Information Agency (EIA) predicts that this Energy Gap will be filled by natural gas and renewables.

- *Coal and Nuclear Power Plants.* Power plant reliance on massive amounts of cool, available water presents a risk where water is now constrained or too warm. This risk manifests in forcing power plants to reduce output or shut down during peak demand periods.[15]

  Investment opportunities exist in power plant production and cooling technologies that are more water efficient. Once-through cooling technologies are heavily regulated, which creates an opportunity for alternative cooling products such as zero liquid discharge technologies (usually a combination of evaporation and wastewater recovery) and hybrid cooling towers (a combination of air and water-based cooling).

  Technologies that allow for seawater, brackish, and recycled wastewater to be used for cooling turbines are poised for growth. However, these are long-term opportunities for large civil engineering and construction firms, such as a Bechtel, Shaw or Fluor. NewWorld has a more asset-light focus, although there may be some discrete opportunities with respect to zero liquid discharge and hybrid cooling towers in the U.S.

- *Natural Gas.* Though natural gas electricity generation uses less water than other forms of electricity at the point of generation, hydraulic fracking uses significant amounts of water in typically water-scarce regions during drilling (several million gallons over the course of a few days for treatment of a single well) and refining and pipeline operations (an additional 400 million gallons of water per day), which can significantly strain water resources.[16] Increasingly, fracking operators have been converting wells in these regions to accommodate brackish water.

  Between January 2011 and September 2012, more than 65.8 billion gallons of water was used for hydraulic fracking (approximately 2 to 10 million gallons of water per well over the course of just a few days), and nearly half (47%) of the

[13] The Water-Energy Nexus discusses the reliance of energy on water.
[14] During the 1990's, the largest regional population growth in the U.S. (25%) occurred in the mountain west, one of the most water-deficient regions. In the southeast, another water deficient region, population increased nearly 14% since 1990. Sandia National Laboratories.
[15] Union of Concerned Scientists
[16] Union of Concerned Scientists; U.S. Department of Energy

fracking wells were developed in areas with high or extremely high water stress.[17] In one county in the Eagle Ford Shale, fracking is estimated to use one-third of the groundwater recharge, sometimes bringing in water from as far as 75 miles away.[18] Many frackwater operators are using recycled water and brackish water for their wells as a result of increasing costs to treat and transport flowback and produced water.[19]

Recycling wastewater from fracking wells costs an average of $2 per barrel and reduces both freshwater and trucking costs. Deep well injection ranges from $1.1 to $22 per barrel depending on the distance between the water source and the disposal well, and discharging frackwater into waterways costs $5 to $20 per barrel.[20] On this cost curve, wastewater reuse is a compelling and increasingly adopted water practice.

Onsite, distributed water recycling is a compelling value proposition for drillers, though complicated by varying flowback and produced water compositions. The composition of produced water varies drastically based on the location and time of drilling (between the initial flowback and produced water returned a few days later[21]). Oil and gas owners and operators appear to have no standard definition on how thoroughly produced water should be treated before reinjection into a wellhead, leading to confusion in the market over how effective various treatment technologies need to be.

Because there is no clear standard and composition varies so drastically in flowback and produced water, it is extremely difficult to choose a technology winner in this space. Some with the "cleanest" results gain little traction, while companies with other “black box” technologies make sales. NewWorld expects that companies that offer full service and customizable (cradle-to-grave) solutions for various wells (proving adaptability to changing water needs), with repeat customer orders, and positive EBITDA (as a proxy for the management being able to market their product effectively) are more likely to be the winners in this space.

NewWorld is seeing interesting technologies and companies, though they are still largely too early and unproven for growth investing. The Firm has seen some attractive treatment and disposal service models. On the infrastructure side, there are possibilities for investment in projects like disposal wells that could benefit from add-on products and services such as those noted above.

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[17] The amount of water consumed per well depends on the geology of the shale, the number of fracturing stages and the amount of water that flows back to the surface (which is estimated to be between 20-80 percent of the water injected). Extremely high water stress means over 80% of available water is already being withdrawn for municipal, industrial, and agricultural uses.

[18] New York Times; Jeff Rubin

[19] Produced and flowback water describe the kind of water that comes back up after initially inject the well with water.

[20] Bloomberg New Energy Finance

[21] These changes include varying levels of salinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS), and other chemical concentrations.

- *Renewable Energy Sources*. Utility-scale solar is not yet a meaningful portion of electricity generating capacity to account for significant water usage. Should utility-scale solar develop, it would use a similar amount of water as fossil-fuel powered electricity generation, in possibly more water-scarce regions (since these are also where the sun shines brightest).[22] However, there is a significantly growing residential and commercial-scale distributed solar market that does not require water in the generation process. Wind is a growing percentage of electricity generation but wind turbine generators are air-cooled and do not impact the water story.

  The investment opportunity here would be in developing more residential and commercial-scale distributed solar projects.

Agriculture

Agriculture, including irrigation, accounts for a relatively stable 31% of U.S. ground and surface water use,[23] and its runoff continues to degrade freshwater resources. Inefficient irrigation systems typically lose as much as half of water input to a field due to evaporation, evapotranspiration (evaporation from plants), or transit losses (leaky pipes).[24] Excessive watering creates an effectively hyponatremic condition for plants where they require more fertilizer (nutrients) to remain healthy and productive. This additional fertilizer use, plus excess water use, creates increasing runoff.[25] California municipalities, for example, continue to find excessive nitrate concentrations in drinking water due to toxic runoff from industrial farms, intensive livestock operations, and agricultural pesticides.[26] The cost to remedy these problems will surely increase the cost burden for customers, but perhaps will also provide needed incentives for more efficient water use.

Systems of ditches, sprinklers, or flood irrigation currently irrigate most fields but waste most of the water used due to runoff, evaporation, and saturated soil. Precision agriculture tools such as drip irrigation can cut water consumption by as much as 50%, while providing co-benefits of increasing crop yields (25% to 35%), thus reducing the need for fertilizers (cost savings) and preventing fungal and bacterial diseases because the soil is not excessively moist.[27] Available financing is a roadblock to adoption of this technology.

Organic agriculture, which has been growing over the past decade, has a positive impact on water resources. For example, "use of more environmentally friendly fertilizers and

[22] New York Times
[23] USGS
[24] USGS
[25] Standard fertilizers overwhelm soils with plant nutrients (nitrogen, phosphorus and/or potassium, of which plants take up only 30% to 50%. The remaining fertilizer is washed into nearby water supplies as runoff, creating eutrophic conditions, disturbing ecosystems, and contaminating drinking water. Organic fertilizers can have a more positive impact on water supplies because they slowly release nutrients. Global Environmental Governance Project
[26] New York Times
[27] Unilever

crop protection agents also protects the groundwater and reduces topsoil runoff. Slow-release fertilizers act selectively and increase yields."[28]

Investment opportunities exist in irrigation efficiency and in possibly reducing nitrates and other toxins from surface waters. Water monitoring, precision agriculture systems, drought-resistant crops, organic fertilizers, and irrigation scheduling are all highly effective, well-proven technologies that are growing rapidly. Nevertheless, NewWorld has yet to see money to be made in the middle and lower middle market for irrigation-related opportunities. Big players like Cargill and John Deere control the customers and can embed their sensors and software into farm operations. Moreover, farmers are reluctant to try anything radically new on their land because their concern is making sure the next crop grows.

Additionally, any investment in the water efficiency space should consider Israeli competitors. Israel has made water efficiency in agriculture a national priority and is now exporting these technologies at a scale of $2 billion to the U.S., Germany, Italy, Spain, Australia, and China.[29] Technologies that reduce nitrates and other toxins are a more risky investment because these markets will likely depend on enforcement of Federal regulations.

Municipal Public Supply/Residential Uses

Water rates have been rising (29 U.S. localities have doubled residential water rates over the past decade, with three municipalities tripling their rates), but little of this revenue stream is going toward upgrading necessary water infrastructure. It is estimated that $335 billion is needed in the next 20 years to upgrade existing U.S. drinking water systems, many of which are over a century old.[30] An additional $298 billion is needed for wastewater and stormwater restoration systems over the next 20 years.[31]

What is obvious is that using the three "R's", (reduce, reuse and recycle) will get more capability out of existing infrastructure and can increase capacity through distributed systems.

- *Strained Water Infrastructure.* Strains on the municipal/residential water infrastructure are caused primarily by the twofold challenges of an aging infrastructure and of increasing demographics requiring more capacity.

  As noted, one large source of water cost is leaky pipes in municipal water distribution systems. The U.S. loses an estimated at 1.7 trillion gallons of water per year owing to leaks,[32] and plugging these leaks represents a possible $167 billion resource benefit, according to McKinsey & Co. In the U.S., $1 trillion is

[28] SAM Robeco Study "Water: a market of the future" ("SAM Water Report"),
[29] Israel commercialized Drip Irrigation and leads the world in household wastewater treatment and reuse in irrigation. Goldman Sachs.
[30] EPA,
[31] American Society of Civil Engineers
[32] Xylem, Inc.

anticipated to be required by 2034 in order to keep up with potable water needs.[33] However, municipalities are suffering from a lack of funding due to budget limitations.

The American Society of Civil Engineers recommends funding this gap by: reinvigorating State Revolving Loan Funds, a program initially funded with $7.5 billion by the Safe Drinking Water Act; eliminating the state cap on private activity bonds for water infrastructure projects to incent private capital inflows; establishing a Federal Water Infrastructure Trust Fund to finance upgrades; and possibly establishing a Water Infrastructure Finance Innovations Authority that could access Treasury funds at low interest rates to support other loans and credit mechanisms for repairs, as well as the introduction of reuse and recycling and water projects, particularly distributed systems. Such programs will take time to implement, which may be too late for many water-stressed communities.

In the meantime, some cities and states have experimented with innovative ways of reducing upgrade costs to existing infrastructure. New York City, for example, is mitigating costs to upgrade treatment plants by investing in maintaining 79,000 acres of upstate watersheds. Other places have begun implementing a number of programs as well, for example "toilet-to-tap" treatment facilities in Texas, where lake levels were under 40% capacity. Only 6% of U.S. municipal wastewater is currently being reused, so there remains enormous potential in this area.

The second problem is the need not just to maintain existing systems, but to upgrade them for additional capacity through reuse and recycling. Beyond encouraging domestic users to change behaviors to conserve water usage, municipalities and states are creating incentives encouraging use of onsite distributed systems owned and operated by private developers/homeowners. For example, building developers are being encouraged with faster building permitting in New York City if they include an onsite wastewater treatment system.

Investment opportunities exist in supporting the management of water for municipal customers. NewWorld continues to explore companies that service water management and leaky water distribution systems. However, relying on municipal customers is an investment risk due to underfunded budgets, high risk-aversion due to strict water regulation, and long purchase order cycles. Still, services for maintaining pipes and reservoirs may be interesting opportunities, especially in sectors where major water service providers such as Veolia and United Water could be reasonable exit targets. NewWorld is also interested in distributed water companies but has not seen enough adoption. Another interesting investment area is monitoring and software management systems for leaks. These would be primarily ESCO-like companies.

[33] American Water Works Association (AWWA)

- *Alternative water sources.* Desalination is booming in countries with scarce water due to the combination of potable water need and falling production prices. Desalination of seawater and brackish water has been slower to develop as a market in the U.S., due to large first costs and continued availability of fresh water in the near term. However, "especially for plants using reverse osmosis membrane technology, operating costs are now 3 to 4 times lower than they were 30 years ago. With production costs of less than $1 per cubic meter of water, these plants are achieving price levels that are getting much closer to conventional water sources."[34]

  Almost all desalination plants use reverse osmosis now, as opposed to thermal, because it takes less energy to run a reverse osmosis desalination plant. It is also a market with projects too big in scale for middle market growth investment; it is more suited to infrastructure investing.

  Investment opportunities in the U.S. will exist in this area more in coming decades. As a general rule, this area is too capital intensive for NewWorld, although there may be limited exceptions.

- *Wastewater Treatment/Reuse*. Of all water available on Earth, 97% is saltwater, 2.5% is freshwater frozen at the poles and in glaciers, and available freshwater is the remaining 0.5%.[35] Once water has been used by humans (cooling nuclear reactors, irrigating cropland, manufacturing paper, or for washing dishes, etc.), that water becomes "wastewater" and is typically processed, cleaned, and fed into infrastructure that drains into nearby bodies of water.

  Plants are being built in the U.S. capable of treating wastewater for reuse. One example is California's Orange County Water District and Orange County Sanitation District which "together have invested approximately $481 million in a water supply project to expand the county's water purification and seawater intrusion barrier facilities, as well as to install a 13-mile pipeline along the Santa Ana River for the reuse of advanced treated wastewater."[36] In New York City, The Solaire has an onsite water treatment facility that processes 30,000 gallons of sewage per day for reuse in cooling towers and toilets.[37] Buildings that include onsite water treatment and reuse systems can receive construction permits more easily than those that do not. Demand for wastewater treatment and reuse is expected to increase dramatically, both for municipal and industrial purposes.

  The largest water-themed investment opportunities for NewWorld will likely be in this category of wastewater recycling, especially distributed treatment systems. NewWorld prefers distributed wastewater treatment more for light industrial and

[34] SAM Water Report
[35] USGS
[36] SAM Water Report
[37] HPB Magazine

commercial applications, as opposed to the municipal (slow) and residential markets (liability risks).

- *Other novel service opportunities*. Such opportunities may exist in ecosystem services. For example, New York City and The Nature Conservancy developed a more sustainable way of dealing with water infrastructure needs by creating conservation lands around upstate reservoirs. These restorations reduced a significant burden on downstream treatment plants that would otherwise have been upgraded. Cities like Philadelphia have also created investment opportunity by jumpstarting a Green Stormwater Infrastructure Initiative designed to prevent overflows of combined sewage and stormwater systems. This program encourages replacing impervious areas with pervious surfaces, improving watershed capacity, encouraging stormwater planters, rain gardens, green roofs, and other decentralized solutions. New York, Los Angeles, Kansas City, Portland, Detroit, Cleveland, and Seattle already have green infrastructure investment programs in place.

  With more demand from other cities, ESCOs working in this space could be interesting investments. NewWorld is more technology agnostic in this area, focusing on the revenue model and the alignment of customer and business interests.

Industrial Uses

Industrial withdrawals[38] have declined in relative terms since 1985 to approximately 4% of total national water withdrawals. This is partially a result of industrial manufacturing plants, particularly water-intensive industries, moving overseas. In the industrial water space, uses of water differ drastically, leading to a wide range of possible solutions.

For example, iron production industries use water for cooling blast furnaces that produce warm, contaminated water; a separate cocktail of contaminants is found in acidic mine waters. Vegetable and fruit industry wastewater, as well as pulp and paper industry waters have high concentrations of total suspended solids (TSS) and biological oxygen demand (BOD), whereas slaughter houses have high levels of antibiotics, growth hormones, blood and offal. These industrial opportunities represent a small portion of a very large water market and even niche applications may become interesting investment opportunities.

Industrial and commercial customers interested in more efficient water processing operations may choose more efficient operational equipment or onsite recycling and reuse treatment options. Similar to water use in the energy industry, industrial mines for iron and steel manufacturing and food processing facilities may choose onsite recycling, However, solutions differ drastically depending on the types of contaminants. Many

[38] Industrial uses include iron and steel industry, mining, food industry, pulp and paper, etc.

industrial manufacturing companies have already pledged various commitments to reducing water waste:[39]

- General Motors reduced water use 32% per vehicle manufactured from 2005 to 2010. One newer GM Mexico facility reuses 90% of its wastewater in the manufacturing process.

- Coca-Cola reduced water consumption 20% between 2004 and 2011. By 2020, it is committed to replenish the amount of water consumed in its production process back into surrounding watersheds.[40]

- DuPont committed to reduce water consumption at its facilities in water stressed areas by 30%.

Investment opportunities exist in water-efficiency and water management technologies that reduce energy intensity and water processing scale. Reuse/recycling and/or desalination are alternative ways of creating additional water resources onsite for large-scale industrial uses. Both segments have experienced strong growth over the past decade and forecasts show 11% CAGR in water recycling and 9.3% CAGR in desalination. [41] However, desalination is asset-heavy and still energy-intensive.

NewWorld prefers wastewater recycling and processing technologies that are relatively asset-light, tested and have a wide range of applications, *e.g.*, in steel, oil and gas, concrete, paper, food, etc. industries. NewWorld believes the investible opportunities lie in treating to purpose, rather than treating to potable. The Firm sees many real, high-growth-potential companies but most are still too early for our consideration.

Commercial Uses

Commercial uses are primarily cleaning-related spaces. Thousands of gallons of water are typically used for commercial cleaning operations per facility per day,[42] not including the amount of water typically inherent to various cleaning supplies. For example, U.S. hospitals use an average of 570 gallons of water per staffed bed per day.[43]

Similar to some industrial initiatives, some national account chains have committed to sustainability initiatives involving water use. For example, Starbucks committed to reduce water consumption in stores 25% by 2015 by introducing filtration systems that reduce wastewater by 50% and replacing "dipper wells" (perpetual-flow cleaning sink faucets) with standard faucets that reduce water use by 15%.

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[39] Goldman Sachs

[40] In 2004, a Coca-Cola bottling plant was shut down in Kerala, India (a $16 million operation) as it was accused of causing groundwater declines that dried up wells of many poor surrounding farmers. Coke's brand imaging was tarnished and has rebuilt itself today as one of the most mindful companies, investing in water-protective measures in the watersheds where it operates.

[41] Cleaning industries typically consume 600 gallons per hour while carpet and floor cleaning consumes 90 gallons of water per hour. Source: Credit Suisse Water – The Pressure is Rising

[42] Environmental Leader

[43] Healthcare Design Magazine

Investment opportunities exist in efficient cleaning solutions and low-cost, niche products that conserve water. NewWorld is not confident that a market is developing here yet due to several factors, including: the technologies are new and not fully tested or produced at scale; the markets may be fragmented; and the benefit and cost savings are not yet great enough to motivate many end users; and few have come forward with substantially differentiated technologies. For example, NewWorld investigated a distributed manufacturer of cleaning products for commercial applications. The company at the time did not have sufficient sales or a sustainably differentiated technology, but the idea of conserving water in the form of cleaning products by installing onsite electrolyzing devices that create cleaning agents was an interesting value proposition for commercial water conservation.

NewWorld would consider investing in filtration system businesses like the products implemented by Starbucks, and water ESCO's that target commercial facilities for audits, financing, and installations of first-order water saving devices (*e.g.*, plugging leaks, efficient toilets and sinks, rainwater collection, cooling tower makeup, etc.).

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As the trends impacting the water market, especially demographic growth and movement, increased infrastructure demand and aging infrastructure challenges, climate change, government policy failures, and accessing additional water sources, the ongoing paradigm shift toward reducing consumption, reusing and recycling of water and treating it to purpose rather than potable is increasingly creating investment opportunities in innovative new growth technologies, products, services, as well as new infrastructure. Onsite, distributed wastewater treatment and recycling products and services that conserve water are particularly appealing to NewWorld,

However, water as an investment segment also presents challenges. Investments may be slower to be realized due to the need for asset intensive capital and the time needed for adoption of new behaviors and standards to replace the collective practice of over-treating water for its purpose. Many new technologies hold attractive promise, but have not yet been produced at scale or been incorporated into successful business models with material profits and are, therefore, too early to be considered for investment by NewWorld.

Also, agriculture, large municipal systems and utility scale power generation tend to be dominated by entrenched large players that will probably realize much of the value as the successful technologies and services emerge over the intermediate term, although there may be discrete opportunities for NewWorld among them. Industrial and commercial applications appear to offer the most opportunity.

NewWorld will continue to seek investment opportunities in companies with asset-light and sustainably-differentiated solutions that reduce water consumption or recycle water that could be near-term takeouts for large water companies and/or other strategic buyers.

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