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Water—The Super Macro of Our Age

Low-Tech Solutions are the Low-Hanging Fruit

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What does water mean to you ? Naturally the answer to that question varies for every one of us, from those for whom water is plentiful, to those who walk miles to receive their daily allotment. In other cases, the issue is one of excess, in the form of frequent flooding or rising sea levels. For many others, the question also relates directly to their business; be it the need for clean water to operate a manufacturing facility or to cool a power plant.

Continuing our focus on our Efficiency 3.0 theme, we turn our attention to Water. Specifically, we will explore the intersection of increasing demand, limited supplies, and the secondary considerations of both as they pertain to fresh water. Unlike any other commodity, water is essential for life and that impacts our story in a significant way. Water issues occur on a global scale, yet are local in impact and resolution with solutions that run the gamut in terms of system complexity and cost.

Our discussion will focus on water issues from the following perspectives:

- The Supply Side
- The Demand Side
- Agricultural Users
- Industrial Users

While estimates vary, there is no mistaking the fact that demand for water over time will increase. Stripping away every other factor, population growth alone drives that baseline demand higher because there is no substitute for water when it comes to sustaining living things. From there, adding in factors such as industrialization and increasing demand for "higher order" foods increases demand above the baseline.

At the same time, the supply curve is relatively fixed given current technologies. Unlike oil where a higher price per barrel causes certain "plays" such as oil sands to be more economical, the supply of water is highly inelastic as a function of price. According to a report by McKinsey (based on IFPRI data), as of 2005 annual global water demand was roughly 4.2 trillion cubic meters (tcm), with total supply at 4.1 tcm. Projecting out to 2030, supply is only projected to edge up to 4.2 tcm, assuming that supply is existing and sustainable at 90% reliability, **with infrastructure investments driving the increase**. Demand, however, is projected to increase to 6.9 tcm, leaving a 2.7 tcm gap (40%).

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Breaking demand into the three primary subcomponents they identify, in 2005 demand was split at 3.0 tcm for Agriculture; 0.7 tcm Industry; and 0.5 tcm for

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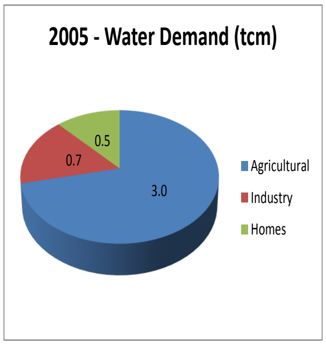
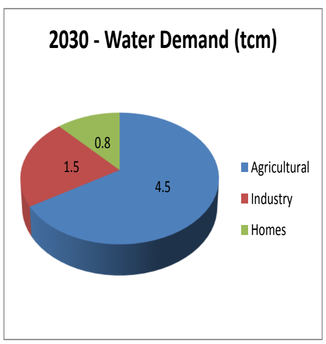




Homes. By 2030, the same three usage buckets are projected to account for demand of 4.5 tcm (Agriculture), 1.5 tcm (Industry), and 0.8 tcm (Homes).[1]

Couching our discussion in terms of simple supply and demand curves, our interest lies in identifying technologies that may offer the potential to meaningfully alter both for the better, whether it be increasing supply and/or decreasing demand. A key caveat though is that such opportunities rarely, if ever, occur without negative consequences. Desalination, for example, can turn salt water into drinkable water, thereby increasing supply. The rub is that present desalination technology requires significant amounts of energy which, when provided by a thermal power plant, requires water. Desalination also offers little utility for land-locked areas, such as much of the US Midwest.

We will also examine the supply of, and demand for, water viewed through the prism of the largest usage buckets – agriculture and industry. Additional points we will emphasize are the secondary and tertiary effects that agriculture and industry have on the water chain. In many instances these factors are quite significant and represent potential flashpoints in times of water scarcity.

The Supply Curve

In totality, the earth has a huge amount of water, covering about 70% of the planet's surface. However, the great majority of this is salt water which is unfit for human consumption, irrigation, or industrial purposes. As the table on the following page shows, over 97% of the global water supply is salt water (Oceans, Seas, and Bays plus Saline Groundwater).

While data in the table is 20 years old as noted in the citation, the fixed nature of the global water supply coupled with what we know about the previous 20 years regarding water-related technologies tells us that the current supply distribution is essentially the same. Furthermore, *absent any technological advancements that enable any transition on the 'Oceans, Seas, and Bays' line to the Percent of Freshwater column,* the picture 20 years from now is also likely to look the same.

Closer study paints an even more troubling picture as heavily-populated nations may suffer disproportionately. Of the 43 countries on which The Economist reports economic data in its regular weekly table of indicators, China is expected to record the highest GDP growth this year at 7.5%. India and Indonesia tie for

Table 1 Global Water Distribution

One estimate of global water distribution				
Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	--	96.54
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,060,000	68.6	1.74
Groundwater	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.007
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001
Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York).				

second at 5.8%. In terms of absolute size in dollar terms, China accounts for $7.32 trillion of GDP; India produces $1.85 trillion; and Indonesia produces $0.846 trillion. As the graphic on the following page shows, China and India are also areas of relative freshwater scarcity. Further stress occurs as both China and India suffer from extensively compromised water resources in terms of pollution. This has an obviously negative impact on usable supply which impedes economic growth and its ability to lift people out of poverty. Said differently, a lack of available, usable water may result in a company choosing to build a factory elsewhere, which equates to missed jobs and economic opportunity.

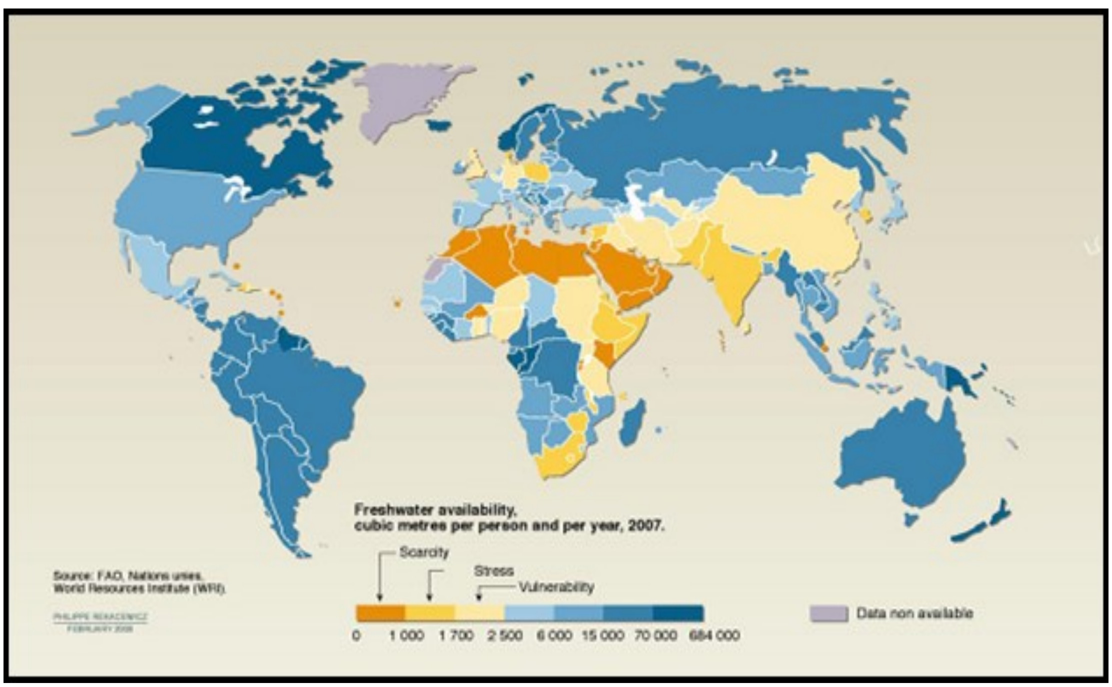
Looking for the silver lining, we also know that where problems exist such as this, there also lie opportunities to deliver solutions which in turn create investment opportunities. A key leg of the stool that must not be ignored is the need for capital. As an example, solutions exist to treat pollution but they have costs. Where innovators can bring products and solutions to market that solve these problems for minimal cost there will undoubtedly be opportunity for investment capital to earn attractive returns.

Increasing Supply

See Page 21 for Water Supply Case Study

As we noted in our introduction, the supply curve is highly inelastic with respect to price. That is not to say the 'curve' is perfectly vertical but rather that an extremely significant upward move in the price of water would need to occur in order to incent large-scale investment in *currently existing* solutions that can increase supply. Present day 'state of the art' for converting saline to potable water is reverse osmosis (RO) whereby salt water is filtered using a membrane which has holes small enough to allow water molecules to pass but not the sodium and chloride ions. Doing so requires pumping water at very high pressure which requires significant amounts of energy. This creates the secondary and tertiary conundrum we noted. Where the electrical generation needed to run the high pressure pumps is provided by thermal power plants (coal, gas, nuclear), there is a need for substantial water to both cool the plants and operate the steam cycle that is used to spin the power producing turbines. One estimate pegs the water usage of these thermal power units at 190,000 million gallons of water per day in the US, which is roughly equivalent to 39% of

Figure 1 **Freshwater Availability by Country**



all freshwater withdrawals.[2] Thus, the production of water incurs costs in the form of electricity and also the opportunity cost of water supply that might otherwise be made available for alternative uses. In some instances the opportunity exists to co-locate renewable power generation, especially solar, with desalination plants. However, solar generation is not capable of supplying power of suitable scale and "dispatchability" to run a commercial scale desalination plant without being tied to the electrical grid.

In addition to "moving" the supply curve, an area that cannot be overlooked with respect to supply is the integrity of the current systems we have. "It has been estimated that 1.7 trillion gallons of water — about 25 percent — leak from the nation's pipes before it can reach a faucet."[3] That is no trifling amount, both in terms of the obvious water loss but also in the secondary impact in the form of the energy and capital that goes into treating and moving water. To put these costs into perspective, we can examine that lost water figure in terms of the electricity required to prepare it for consumption. According to Energystar, it takes 11kWh of energy to deliver 1,000 gallons of water to US consumers on average.[4] The all-in rolling twelve month cost of electricity in the US, according to the EIA, is 9.92 cents per kWh. That equates to $1.8bn dollars per year of otherwise avoidable expense.

In response, Congress amended the Safe Drinking Water Act in 1996 to establish the Drinking Water State Revolving Fund, which serves to provide funds for infrastructure improvements to "drinking water" systems. As part of that amendment the EPA was instructed to provide a quadrennial (every four years) report to Congress discussing the investment needs of such systems over the following twenty year period. The fifth such survey was released on June 4, 2013 and it detailed an aggregate need of $384 billion over the next 20 years. Key points made in the report include[5]:

- Distribution and transmission: $247.5 billion to replace or refurbish aging or deteriorating lines
- Treatment: $72.5 billion to construct, expand or rehabilitate infrastructure to reduce contamination
- Storage: $39.5 billion to construct, rehabilitate or cover finished water storage reservoirs
- Source: $20.5 billion to construct or rehabilitate intake structures, wells and spring collectors

From an investment perspective, the addressable market opportunity is quite immense. However, to provide some context to those obviously large figures, the EPA report prior to the one just released cited "Funds Available for Assistance" of $14.4 billion with cumulative disbursement to date (as of 2007) of $10.1 billion. Those two figures combined equate to only 6.4% of the total aggregate need identified in the report. Therefore, in addition to the opportunity at hand for product/solution providers, we also see a marketplace where potential exists for innovative financing schemes much like the solar leasing model that has gained traction in that industry.

According to the EPA, as of 2010 there were roughly 155,000 public water systems in the US. That population is further stratified by the number of connections served. The EPA defines these groups as Small (less than 10,000 served), Medium (10,000 – 50,000), Large (50,000 – 100,000), and Very Large (>100,000). The "Small" category accounts for an overwhelming majority of the number of systems at roughly 146,000 or ~94%. These systems serve over 39 million connections for an average of 270 connections per system. At the high end, only 402 systems are defined as Very Large, with a connection average of roughly 327,000.

Small systems generally have more difficulty accessing the capital needed to maintain and grow their infrastructure. Capital investment into system infrastructure is a cost normally passed on to customers in the form of increased rates, typically set by a state utility commission. These commissioners must balance the need for capital investment with a desire to not create undue economic hardship for customers. As a result, system investments often trail the amount truly required.

Publicly-traded parent companies own a fair number of these small systems which brings improved cost of capital and other efficiencies such as shared back-office functions. Hard data on the number of systems that fall into this category is not available, but one estimate provided by water meter manufacturer Badger Meter (BMI – NR) estimates the percentage of systems owned by publicly-traded utilities at about 5%. This leaves a large number of systems remaining that likely face capital-based challenges because they don't have economies of scale. In response to this the EPA recently issued an RFP for the creation of a National Center for Innovation in Small Drinking Water

Systems.[6] As noted in the RFP, "small systems do not typically have the resources to seek out, evaluate and apply innovative approaches that could provide better drinking water contamination solutions and improve public health protection."

Supply Side—Challenge Summary

- Steadily increasing supply deficit.
- System failures lead to water loss.
- System failures result in excess cost and energy.
- Pollution is negatively impacting the freshwater supply.
- The majority of water system operators are small which often creates capital constraints.

Supply Side—Opportunity Summary

- Over the long term, solutions that can effectively transform saline water to freshwater at acceptable cost levels will be in demand.
- Solutions that can provide accurate fault detection have appeal but that is tempered by budgets that are often limited.
- "Distributed" water treatment systems which allow businesses and/or localities to address their own water quality issues.
- "Low Tech" solutions such as rain barrels and cisterns offer promise as businesses and people look for ways to insure they have an adequate supply of usable water.
- Water recycling solutions which allow for more "closed" water loops.

The Demand Curve

Compared with the supply curve, the demand curve is more elastic at an aggregate level. Locally, demand curves vary but with the primary determinant factor being availability of supply rather than price. In parts of the US, water is essentially free as it is delivered to people via un-metered lines. It is indeed rare to see water carrying a variable cost at the residential level which is truly reflective of the underlying economics, even in the arid southwest of the US. For the average US homeowner, the water bill is likely well below that of the electric bill. According to Leakbird.com, which is a water conservation-oriented blog, the average US water bill comes out to around $51.00 per month.[7] This compares with an average monthly electric bill of $110.14 according to the EIA.[8]

The primary tool with which demand can be reduced is increased efficiency. Products and solutions run the gamut although we can't ignore significant gains that can be realized from obvious, simple behavior changes such as turning off the water while we brush our teeth; turning off sprinkler systems when it is raining; planting less water-intensive ornamental vegetation; and taking shorter showers.

The list of such measures can go on and on but, absent progressive, dynamic pricing, most people are not very driven to alter their behavior at the residential level. Regulatory drivers can pick up some slack by mandating implementation of certain products/solutions such as high efficiency appliances or rain water harvesting systems. However, the most significant impact occurs at the commercial/industrial level where efficiency measures translate into meaningful ROI metrics.

An important point to note is that while efficiency measures can make a very meaningful impact on the supply-demand equation in the short and long term, water, much more often than not, has no substitute. This means that there will likely come a day when water prices will need to adjust upward in a dramatic fashion in order to compel investment in supply-side solutions that can operate at the scale necessary to meaningfully drive supply expansion.

Usage Viewpoints

Agriculture dominates the freshwater demand picture. Based on data cited earlier in this report, as of 2005 agriculture accounted for over 71% of demand with that percentage projected to stand at 65% in 2030. On an absolute basis, agricultural water demand is expected to grow 50% (from 3.0 tcm to 4.5 tcm) over that period. This is driven by population growth along with improved living conditions. According to the UN, over the 2000 – 2050 period the world population is expected to grow 47% to 8.9 billion.[9] While this period does not exactly match that of our water demand estimation period, we still see the pattern and rate of growth as being very similar. In addition to the simple increase in numbers, additional dynamics such as improved standards of living increase the demand for water due to demand for higher order foods along with other "consumptive ends" such as household appliances.

Agriculture

For our purposes, we include the raising of livestock in our agriculture section. From the standpoint of water demand we feel this is appropriate as livestock consume water, both directly in the form of drinking water and indirectly in the form of water used to grow their feed. Similarly, as with agriculture, the primary demand driver for livestock is human consumption.

In our introduction we cited current and long term agricultural water consumption statistics. Looking at the table below we can see the connection from those "high level" figures to what the actual needs are "in the field." Translating this data to some equivalent "per person" statistic is not so easy unfortunately. We can however approach this from a different "proxy" perspective. Using USDA data we see that global grains production for the 2011/2012 period was 2,317 million metric tons (mmt).[11] That includes wheat, coarse grains, and milled rice. We use grains as our proxy as they are a diet

Table 2 **Crop/Livestock Water Requirements**[10]

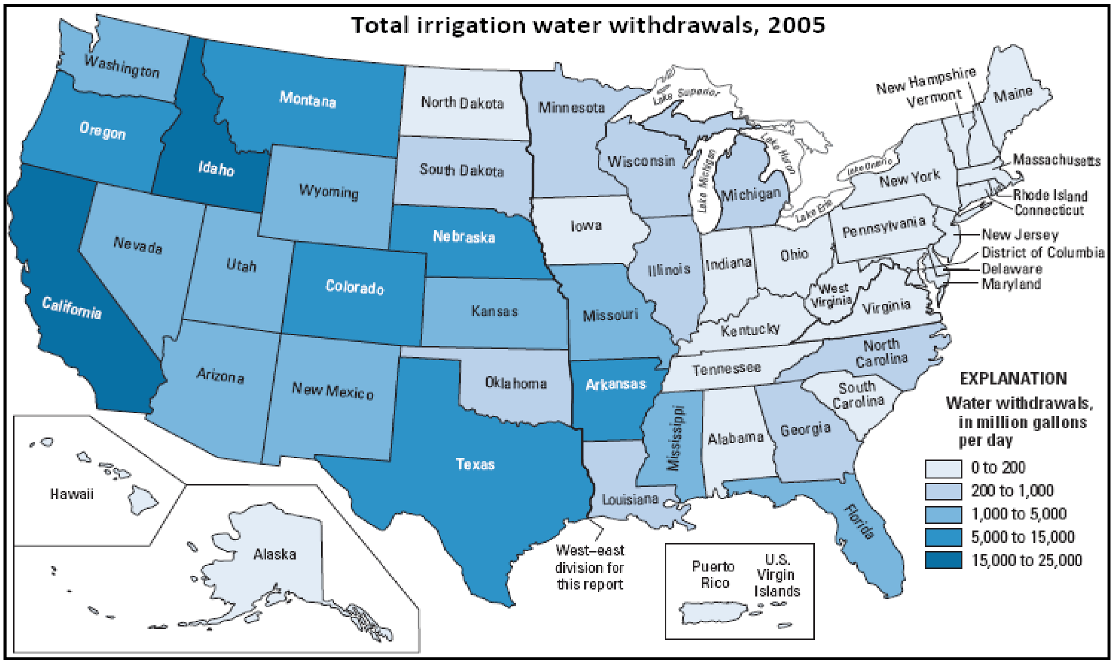
	litre/kg	litre/kcal	litre/gram protein	litre/gram fat
Sugar crops	197	0.69	0.0	0.0
Vegetables	322	1.34	26	154
Starchy roots	387	0.47	31	226
Fruits	962	2.09	180	348
Cereals	1644	0.51	21	112
Oil crops	2364	0.81	16	11
Pulses	4055	1.19	19	180
Nuts	9063	3.63	139	47
Milk	1020	1.82	31	33
Eggs	3265	2.29	29	33
Chicken meat	4325	3.00	34	43
Butter	5553	0.72	0.0	6.4
Pig meat	5988	2.15	57	23
Sheep/goat meat	8763	4.25	63	54
Bovine meat	15415	10.19	112	153

Source: Mekonnen and Hoekstra (2010)

staple for much of the world's population. Earlier we cited a statistic predicting global population growth of 47% from now to the year 2050. Using global grain production as our proxy we can then conclude that production will need to hit 3,406mmt in 2050 to maintain the same "food coverage".
While these figures are large they are also abstract in that they don't convey much in the way of relative impact on both land and water needs to achieve the necessary production levels. What we can say is at a high level there is a finite amount of land that is suitable for farming, human habitation, livestock habitation, or all the above.

The implication then for water is one of forced efficiency. It will be non-negotiable as multiple forces converge with water as the common thread. As the global population continues to swell, more land will be required for living space leading to a double-whammy for agriculture as it will need to provide for more while at the same time being forced to do so from more marginal land. According to the EPA, "Less than 15% of U.S. cropland is irrigated, although irrigation is essential for crop production in some of the most productive areas

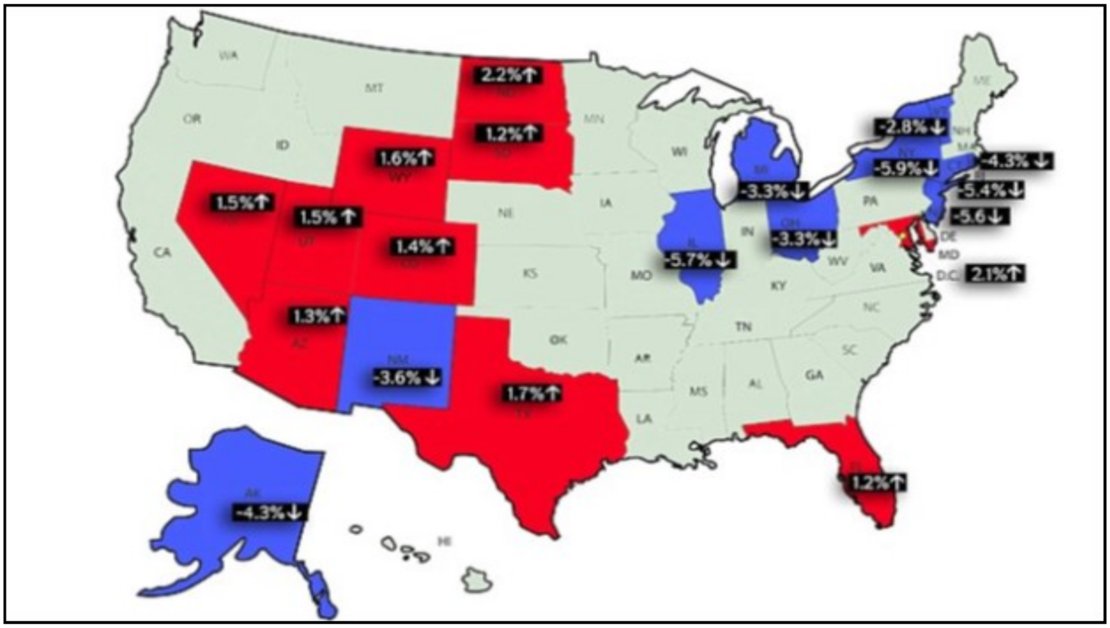
Figure 2 **US Irrigation by State**[13]



of the country. For instance, in Arizona, home to some of the highest corn yields in the country (208 bushel per acre state average in 2001 compared to 152 for Illinois), much of the crop is under continuous irrigation from planting until harvest."[12]

As the graphic on the prior page shows, water withdrawals for irrigation are more significant in the west, owing to the fact that there is more farming acreage than in the east along with the fact that much of the west is more arid. If we compare the graphic with the one below which depicts recent population growth in terms of states seeing the most gain and loss, aside from Florida and

Figure 3 **US Population Changes**[14]



Maryland all the states recording growth are in the west. To be clear, the graphic below is backward-looking and may not be indicative of future trends but for now there appears to be a significant overlap in terms of states seeing population growth also being states where the agriculture industry relies heavily on irrigation.

The "input" side of the water equation with respect to agriculture only tells half of the story. In the case of crops, the drive to maximize yields brings the use of fertilizers and pesticides. Even when natural substances are used excess run-off can lead to imbalances as they accumulate in water ecosystems. This can occur as each individual farm plot is part of a larger watershed into which the run-off flows. In the eastern US for example, the Chesapeake Bay watershed is heavily impacted by the Susquehanna River which is fed by nearly half of the state of Pennsylvania.

According to the 2002 agricultural census, Pennsylvania ranked 19th among the states in overall agriculture production. Dairy farming is cited as the largest sub-industry in the state, ranking 4th overall with a wide variety of other crops and livestock produced on the state's 63,000+ farms. Given the size of the watershed feeding the Susquehanna River depicted in our graphic, it becomes easy to see how fertilizer and other run off can begin to accumulate by the time it reaches the Chesapeake Bay.

Figure 4 Chesapeake Bay Watershed

Source: PA Dept of Environmental Protection

Excess nutrient levels, due primarily to fertilizers, negatively impact the Bay in several ways. One impact is felt in the oxygen levels available to sustain aquatic life. As the ecosystem sees the nutrient level exceed its natural equilibrium state, organisms such as algae thrive. Because algae is living it also 'consumes' oxygen from the water thereby reducing the amount remaining for other life such as fish. As this impact ripples up the food chain the result is "dead spots" where water nutrient levels become elevated enough that the algae crowds out all other forms of aquatic life. This, in turn, impacts industries such as fishing which depend on that aquatic life to survive.

Agriculture—Challenge Summary

For the agriculture industry as a whole, we identify major challenges faced as follows:

- Long term population growth (US and globally) drives a need to increase food production.

- Population growth reduces land area available for farming, especially high quality land.
- Population growth increases aggregate water demand with agriculture one of many "demanders".
- Increased water demand coupled with static supply is likely to make secondary issues such as runoff more critical.
- Irrigation-based agriculture may hit an inflection point where there is inadequate groundwater available to support such operations.

Agriculture—Opportunity Summary

See Page 22 for Opportunity Case Study

The challenges we highlight are not an exhaustive list and as the agriculture industry evolves and adapts we see several key areas of opportunity related to the water component:

- Irrigation methods that maximize efficiency.
- Real time soil monitoring that drives more acute irrigation.
- Integration with weather analytics.
- Rain water harvesting.
- Crops that are less water dependent.

Commercial/Industrial Usage

The criticality of ensuring water supply for industry can be highlighted by recent actions taken by legislators in Texas. This past May they approved a $2 billion water infrastructure fund "designed to set up a water infrastructure bank that will provide money for reservoirs, conservation programs and other projects." Governor Rick Perry was a staunch advocate of the legislation, which he continued to push for in order to continue the "Texas Miracle" of attracting businesses to the state. Speaking at the signing of the bill, "It is hard to overstate the importance of this legislation," Perry said, speaking about how a strong supply of potable water was critical to the state's economic growth.[15]

While voters in Texas now need to approve the legislation in November, the signing of this bill shows that leadership in Texas "gets it" when it comes to water. Where the infrastructure bank enables various entities to undertake projects that would have otherwise remained on the drawing board there is also an obvious positive catalyst for companies that provide products and solutions in the water space.

Water use by industry typically occurs in one or both of two separate processes. The first is the cooling loop which serves to regulate temperature in a facility. An example of a similar system is your car's cooling process where water (and/ or antifreeze) is circulated around the engine, absorbing heat in the process, and then passes through a radiator where air passing over the radiator body cools the water. This is a closed loop where the same water travels the loop over and over, rarely requiring any new water to enter the system. Many industrial facilities use a process which is essentially the same to cool buildings and equipment.

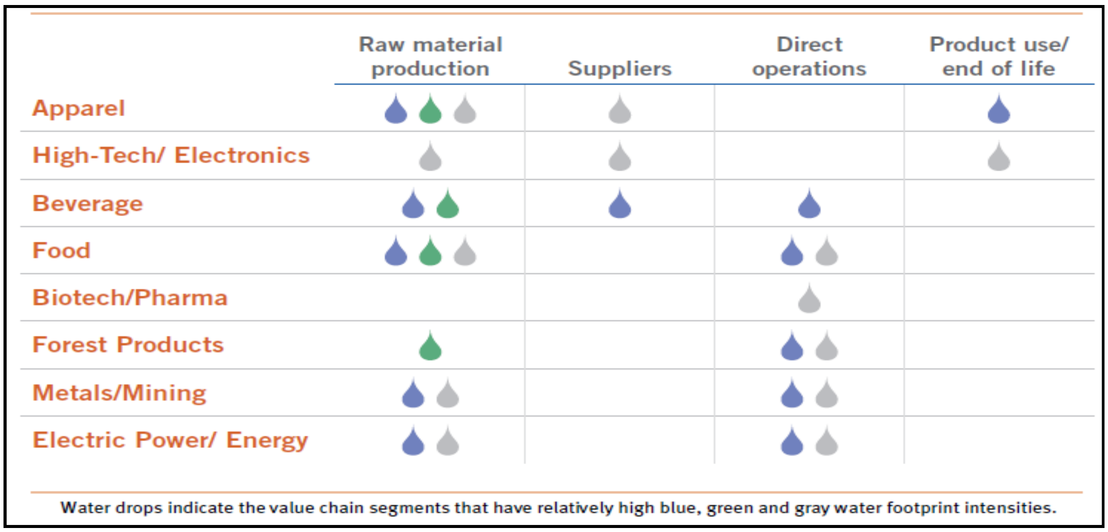
The second type of process is the manufacturing process, where water is used in some form or function in the actual production of another good. This type of process differs from the prior example in that the loop is not closed, meaning "new" water is always a necessary system input. An easy example of this would be a soda bottling facility. Water is combined with other ingredients to produce a beverage which goes out the door.

When we think of the beverage industry our first thought naturally gravitates to what is in the bottle given that water is normally the chief ingredient. However, that does not tell the whole story of the industry's reliance on water. "The vast majority of the water the sector consumes, though, is used not in its factories or bottling plants, but in the fields where ingredients like sugar, barley and tea are grown. For instance, it takes 170 to 310 liters of water, or 45 to 82 gallons, to produce a half liter of soda, 300 liters to make a liter of beer, and 140 liters to produce the ingredients that go into one cup of coffee, according to the Water Footprint Network, a scientific group that works with many big food and drink companies on water issues."[16] To put these figures in context, the same article goes on to note that as much as 98% of the total water impact occurs in the growing of the crops used to make the end product.

This dynamic poses a significant challenge as the water usage in that "agrisupply" network is rarely under the direct control of the beverage company. Using a beer company as an example, the grains used to make the beer – barley and hops – are normally grown by a farmer who must ultimately make decisions on his own water use. The apparel industry faces a similar dynamic in that cotton cultivation requires significant amounts of water – 25 cubic meters of water are needed to produce enough cotton (~250 grams) to make a single T-shirt.[17]

In fact, as the graphic below shows, this "upstream" effect is pervasive across many industrial verticals, often exhibiting greater water intensity than the direct production process. This, in our view, is an extremely important point to note from an investment perspective. In effect, given the scarcity potential, water has the potential to, and likely will over time, become a major factor throughout

Figure 5 Water Footprint by Sector[18]



corporate supply chains. That is not to imply that water is not a relevant concern now but rather that the endpoint in the chain, such as a foods company, may be forced to do more to safeguard the integrity of the chain from a water standpoint.

This issue of supply chain integrity as it pertains to water is already at a flash-point in certain areas, with "frac" drilling, power generation and ethanol production examples that immediately come to mind. In both cases we see the convergence of the water-energy nexus which we expect to become an increasingly important issue in society.

Frac Usage

"Frac" drilling rests on the principle of fracturing underground rock formations, thereby releasing gas and hydrocarbons which were not otherwise free to flow up out of a well. The "conventional" technology for doing so consists of pumping a water/solid mix at high pressure into a well, with the ingredients and mixture varying based on the geology of the targeted well. While this makes it difficult to zero in on water consumption statistics, one industry publication puts the typical deep shale gas or oil well water need for a frac job at 5 million gallons. For comparison, that amount is about the same as used by[19]:

- **New York City** in approximately **6.3 minutes**
- A 1,000 megawatt coal-fired **power plant** in **10.8 hours**
- A **golf course** in **22.5 days**
- **6.75 acres of corn** in a season

In areas of ample water access this is a manageable amount. However, where the opposite is true, as is the case for a significant portion of Texas at present, a flash-point occurs. As a whole, the state of Texas is experiencing a drought with some areas deemed to be in "exceptional drought" while other areas are "abnormally dry" as shown in the top graphic in appendix 1. In the accompanying graphic we show the major shale plays in the state and note the Barnett and Bend formations as being situated in areas experiencing the worst drought conditions.

In some of these areas, towns are even being forced to truck in water as a result of depleted reservoirs and/or falling aquifer levels that render wells dry. Where basic human needs are in danger of not being met, other "demanders" such as frac drilling operations become marginalized. While being sensitive to these concerns, the financial impact on companies involved in the frac industry is also real.

Power Gen Usage

Texas also represents a flash-point for power generation although the issue exists in many other locales. In Texas, the drought creates a circular effect where heat, as a driver of drought, creates marginal demand for electricity, primarily for air conditioning. Over time, as a result of normal market forces, this would result in the construction of additional generation capacity as the industry responds to the demand. However, given drought conditions the water component that accompanies thermal power plant construction (as noted earlier in this report) represents an outsized factor in the equation.

In some instances there simply is not enough of a reliable water source available. In others, water may be available but local residents and businesses need to properly ascertain how much water will be left for their own needs once a new power plant dips its straw into the local reservoir. As we noted in the prior section on frac usage, a 1,000 MW coal-fired power plant uses roughly 5 million gallons of water in just over 10 hours. While this may sound extreme on the surface, such power plants do not actually "consume" water in the same manner as a bottling plant for example. The water used is normally part of a closed loop and/or discharged back into the environment. Even so, in areas where water conditions are dire, the incremental demand can be very meaningful.

Ethanol Usage

We also highlight ethanol production although its impact on water is changing as newer "cellulosic" techniques begin to displace corn as the primary process input. The discussion remains relevant as it is a recent, relevant example of unintended consequences and impact, including the water equilibrium. Out of the gate, the "sales pitch" was an easy one—homegrown fuel to reduce/replace reliance on foreign oil for our cars. As ethanol blending mandates and tariff schemes went into effect, corn prices skyrocketed due to its role as the primary ingredient in the ethanol production process. It naturally followed that farmers chose to grow more corn due to crop price arbitrage.

Corn is a relatively thirsty crop which, in turn, led farmers to irrigation in order to support their fields; high market prices more than offset the cost of irrigation. Now, several years later, rapidly depleting aquifers underneath much of the US Midwest offer testament to the secondary effects of the ethanol rush.

Fortunately, second generation ethanol technologies have advanced such that other inputs, such as switch-grass, agricultural waste, and wood chips, can be used effectively. These inputs are less water intensive and in some cases byproducts of other processes and thus 'water neutral'.

Industry—Challenge Summary

The challenges faced by industrial water users will natural vary from industry to industry. Even so, there are a number of common threads and similarities which we can identify:

- Water supply is likely to be less and less of a "given".
- "Industry" will be forced to advocate for its share of the water supply,

especially in the political sphere.
- Industries with significant water input profiles will need to "think vertically" with respect to water.
- The price of water is likely to go up and businesses should plan for this eventuality.

Industry—Opportunity Summary

The beauty of our capitalist economy and culture of innovation is that this wide range of challenges also creates a litany of opportunities for profitable investment and business development. Among these threads we like:

See Page 23 for Opportunity Case Study

- Substitute technologies when/where applicable. An example of this could be the usage of alternative "proppants" for frac drilling in lieu of water.
- Efficiency solutions that allow businesses to use less water will be in demand.
- Products/solutions such as rainwater capture systems and cisterns that enable businesses to control their own supply will have appeal.
- Geographies with favorable long-term water supplies will have a significant advantage in attracting businesses.

Conclusions

As we embarked on this research project one objective among many was to seek out "The Innovation Edge" where exciting products/solutions might offer the means to bring the long term supply/demand mismatch into harmony. The more we studied the issues and the industry the more it became apparent to us that, while there are certainly exciting projects and businesses being developed, the story at present is much more one of low-tech, common-sense approaches.

In our agriculture case study we highlight the significant efficiency that can be gained by deploying simple plastic sheeting in irrigation ditches. That is hardly the stuff of Popular Mechanics magazine or nose-bleed venture capital investment but the simple truth is that studies show it can deliver meaningful results. Examples like this abound, from rain-water capture to simple behavioral changes.

This is not to say there is not a place for innovation and 'cutting edge' technology. In fact, areas such as improved reverse osmosis filter design offer long term potential on the supply side while usage of biometrics offers promise on the demand side. Given the scope of the supply-side opportunity, investment in long-term, 'scale' solutions offers significant reward potential. Current reality however is that such opportunities are overwhelmingly 'lab scale' and thus have yet to deliver real world impact. This results in a somewhat bifurcated investment perspective as returns on capital in the near-term are likely to favor existing, low-tech solutions, such as replacing leaky pipes, while long term, higher-return seekers might also look to emerging technologies devoted to desalinating water more efficiently.

FATHOM Transaction

Deal Stats:

$5mn cash at closing

$15mn potential earn out

TTM Rev's $3.0mn

Max P/S=6.6x

As with many emergent technologies, innovation will be incremental and thus more suited to private equity stewardship. Water utilities, which represent a significant portion of the end-market for many suppliers, are very risk averse by nature and thus introduction of products/solutions into that market is very slow. We look to the example of Global Water Resources (GWR.T—NR) as a prime example of this. GWR developed a "smart grid for water" application called FATHOM which it marketed to small water utilities. FATHOM is a cloud-based system that offers significant improvements to a utility's customer engagement systems, billing, and asset management. Despite seemingly attractive pay-back periods and other operational benefits, GWR encountered significant inertia in the market and ultimately decided to sell the FATHOM unit to private equity firm XPV Capital.

Another areas seeing significant development and investment activity is the treatment of water used for frack drilling. In our report we noted that such drilling consumes significant amounts of water and that water must be cleaned before it is (ideally) re-used in the well or returned to the environment. The opportunity is large and immediate. Predictably, a large number of companies have entered the space, some with relatively simple solutions and others with more proprietary processes. To date, we have not seen a clear winner emerge in this highly-fragmented sub-sector. Even so, this has been an area where venture capital has played, given the scope of the market opportunity.

Now what ?

Looking at the basic supply/demand data, the gravity of the water "super macro" is rather evident. Even so, with water being a local phenomenon, that seemingly evident picture often falls away. Put another way, would the US as a nation have a different attitude toward comprehensive water policy and investment if the nation's capital was Phoenix, AZ or Lubbock, TX ? In fact, Washington D.C. is more likely to be at risk from excess water in the form of rising sea levels than it is to experience significant, prolonged drought. The same holds true for New York City. And Boston. And Miami. The net result is that it becomes easy for water-related thinking to lose prominence in our national psyche as the corridors of power and capital are not water-starved areas.

In our view, this also creates opportunity for those seeking to capitalize on these opportunities to get ahead of the curve. An unfortunate human trait is the tendency to react only when crisis hits, rather than in anticipation of such. Ample studies have been made and reports given detailing the decrepit state of much of our nation's infrastructure yet most of what is done consists of patchwork repairs rather than the significant overhaul needed. Only when a major bridge fails, as has happened several times, do calls to arms get sounded. We noted how the Texas legislature approved a large water fund but it did not come easy—a point worth noting. As acute as the water situation is in that state significant opposition to the bill was present. Imagine then the difficulty of securing public funding on the scale needed just to maintain our existing infrastructure in areas where water supply/demand is not a problem.

Another key point is the fact that the preponderance of water infrastructure spending is done by public entities. For solutions providers and investors, private-side customers often represent an easier sales channel as purchase decisions are framed by standard business case and budgeting decisions. The public side, while representing an enormous market opportunity, is also plagued by political machinations and other factors, such as pricing decisions, which are beyond the control of the customer entity. For younger companies offering products/solutions in the space, a reliance on public-side customers can be an outsized risk as a result. Investors supporting such companies will need to have patience.

Given the elemental supply and demand forces at work that we have noted, we are resolute in our opinion that the "water space" will offer compelling opportunities for capital investment for years to come. The present state of the market is such that current technologies have ample runway while the macro-supply dynamic is sufficiently appealing to attract R&D investment in pursuit of a true "killer app" which would allow for large-scale, economic conversion of saline water to potable water.

Case Study:

Supply Side—Making Desalination More Affordable

Saline water can be converted to potable water but the only presently-available technology that can do so at scale and at a cost level that does not destroy the economic feasibility is reverse osmosis (RO). That is not to say that the war is won however, as RO is very energy intensive and costly, with the economics really only justifiable in truly water-stressed areas such as the Middle East. As a result, one area where we see opportunity is products/solutions that can deliver appreciable cost reduction, whether it be improved membrane technology which requires less water pressure or other areas such as energy recapture.

One technology provider addressing the latter phenomenon is Energy Recovery Inc.(ERII-NR), which makes a device that captures the majority of the kinetic energy contained in the concentrate stream that does not pass through the RO membrane. In doing so, ERI claims to be able to allow for up to a 40% - 60% reduction in the size of the pump needed for the RO loop. A smaller pump requires a significantly less amount of energy to operate, thus yielding reduced operating expense for an RO facility. On its corporate website, ERI notes that its devices save 12 billion kilowatt hours of energy each year, resulting in a cost savings of $1.2bn.

ERI provides a number of case studies and white papers on its website which provide detail on a number of projects in operation and in development. As the table below shows, the pressure recovery devices supplied by the company lead to significant, tangible savings in energy consumption, cost, and carbon dioxide emissions.

Table 3 ERI—Summary of Savings Gained

ERI Case Studies Summary of Key Figures

		Annual Savings		
Facility	Planned Production	Financial (USD)	Energy (kWh)	CO2 (metric tons)
Tianjin, China	150,000 cm/day	$7,450,000	74,500,000	44,000
Istanbul, Turkey	9,600 cm/day	$800,000	6,200,000	3,627
Chennai, India	100,000 cm/day	$9,548,400	95,484,000	na
Yuhuan, China	36,000 cm/day	$2,700,000	27,000,000	16,000

source: http://www.energyrecovery.com/case-studies

Case Study:

Agricultural Opportunity—Significant Gains Via Low-Tech Solutions

An acre-foot of water equals just under 326,000 gallons.

As we noted earlier, water is very much a local phenomenon and in some areas the price of water, especially for agricultural users when framed in "all in" costs, is volatile despite markedly less price volatility at the aggregate level. In San Diego County for example, the cost of water rose from $500 per acre foot in 2005 to $1,200 in 2011. Looking back at our graphic on page 10, in California, irrigation water withdrawals (in 2005) were listed at 15,000 to 25,000 million gallons per day. At the low end of that range, using the 2011 San Diego rate of $1,200 per acre foot (which we admit is not a good proxy for the state as a whole), the associated cost would be $55.2mn per day.

A study commissioned by the Australian government in 2009 highlights real world examples of how agricultural water efficiency can be improved. As noted in the study, there are two primary areas for improving water use efficiency. One is mitigating evaporation and seepage while the other is matching water to plant needs with precision irrigation. Regarding evaporation and seepage:

> "This includes water leakage from on-farm conveyance channels and storages. Mitigation strategies include lining with plastic sheeting and deepening dams to reduce evaporation. Significant volumes of water are lost every year Australia-wide through evaporation and seepage from farm storages and on-farm conveyance channels. Very little information had been available until recently to enable the calculation of evaporation losses from canals and farm dams. A recent study[10] estimated that as much as 7,000 gigalitres is lost by evaporation from farm dams in the Queensland section of the MDB alone, and the study estimated that it would be realistic to achieve an evaporation saving from this amount in the order of 1,500 gigalitres[11]. This compares to the Queensland section of the MDB's estimated on-farm storage of water at 20,100 gigalitres[12] and total annual water extraction for agriculture of 12,191 gigalitres[13]. If evaporation can be understood across different climate zones and conditions, then it may be possible to 'gain' water by undertaking efficiency measures to limit evaporation."[21]

Parsing that data, the "savings rate" is roughly 12% (1,500 gigalitres saved versus 12,191 gigalitres of total annual extraction). Framing that versus the figures in the paragraph at the top of the page, the financial savings across the state of California would be roughly $6.8mn per day. In water volume terms, the savings (based on the low end of the range as well) would be 1,800 million gallons per day or 657 billions gallons a year. These are very meaningful savings, in both financial and liquid terms, that can be had be implementing low -tech solutions such as lining conveyance channels with plastic sheeting and deepening dams.

Case Study:

Commercial/Industrial Opportunity—Rain Water Harvesting

In non-residential settings we see rain water harvesting having appeal for multiple reasons:

- Water collected from rain falling on the roof can be saved, creating a source of supply when/if it might not be readily available from conventional sources.
- Water collected can displace a portion of ongoing water purchases from the utility, creating financial savings.
- Water collected can reduce run-off, thus creating savings in the form of smaller run-off systems and/or sewerage fees
- Rain water harvesting systems can earn LEED points which are often prominently featured in corporate sustainability programs.

The Home Depot (HD-NR) is an example of a business that has chosen to utilize rain water harvesting systems among other water efficiency initiatives. On the company's corporate sustainability page online, the following water-related points are noted:

- Using new irrigation systems that reduce water usage by 35%.
- Dual flush, low flow toilets and urinals, low flow faucets that reduce water usage by 40%.
- Rain water reclamation tanks installed in 36 Garden Centers=500,000 gallons of water saved per year per store.

Unlike the agricultural community in California noted in our prior case study, even across its total corporate footprint Home Depot likely consumes much less water, both in absolute terms and as a percentage of its operating budget. Thus, while the measures deployed yield cost savings (which, as a publicly-traded company, are meaningful), much of the corporate benefit is tied to its sustainability program.

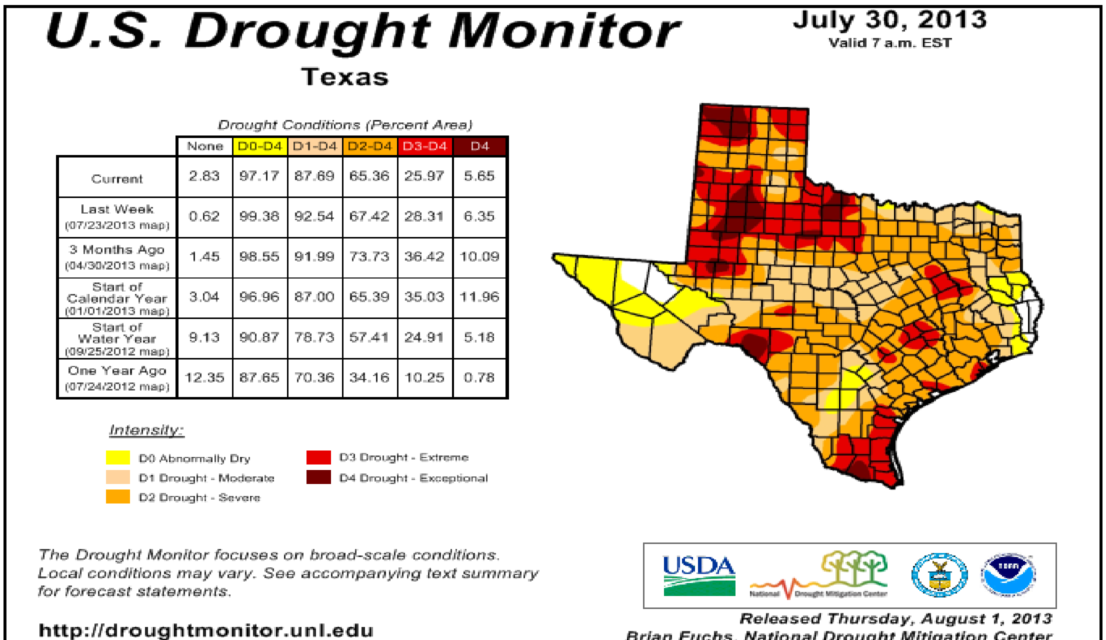
ARCSA—American Rainwater Catchment Systems Association

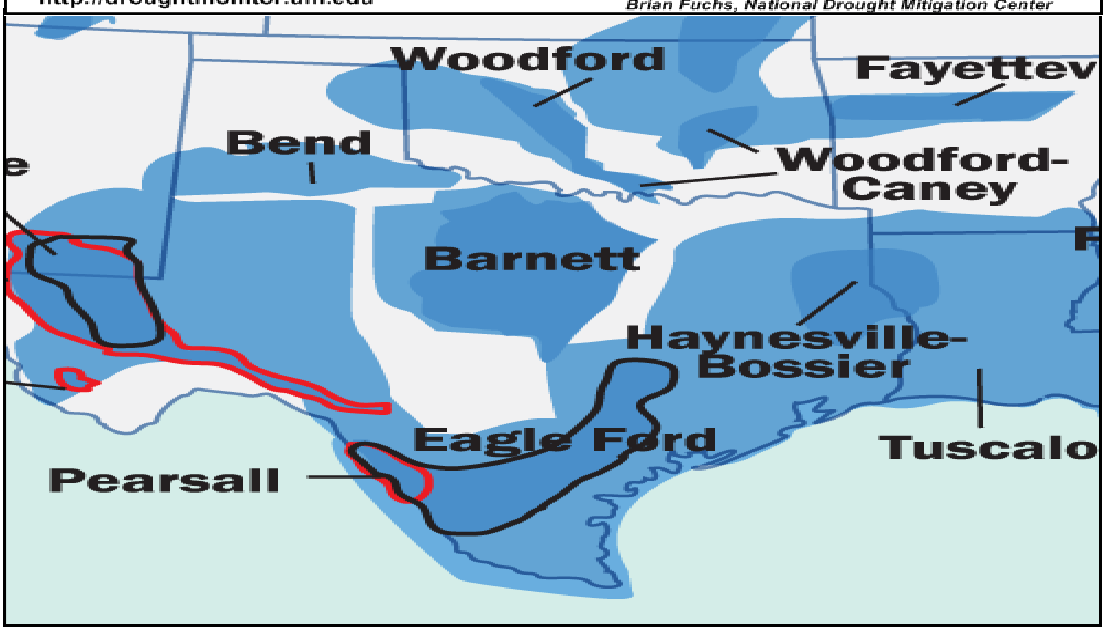
www.arcsa.org

When/if large swaths of the C&I community begin to incorporate such systems however, we see the aggregate water supply/demand equation being impacted. According to ARCSA, the primary tool to stimulate such adoption is by changing building codes. In Tucson, AZ, for example, new non-residential construction must derive at least 20% of its water usage from rain water capture systems. This creates new revenue opportunities for both suppliers of such systems as well as those providing installation and service, such as engineering companies, irrigation systems companies, and/or building management entities. In order to promote uniformity and quality, ARCSA is working to provide licensing/ accreditation for those in the field.

September 9, 2013

Appendix 1– Texas Drought Monitor Shale Plays





Source: http://www.energyfromshale.org/sites/default/files/shale-plays/shale_barnett.png

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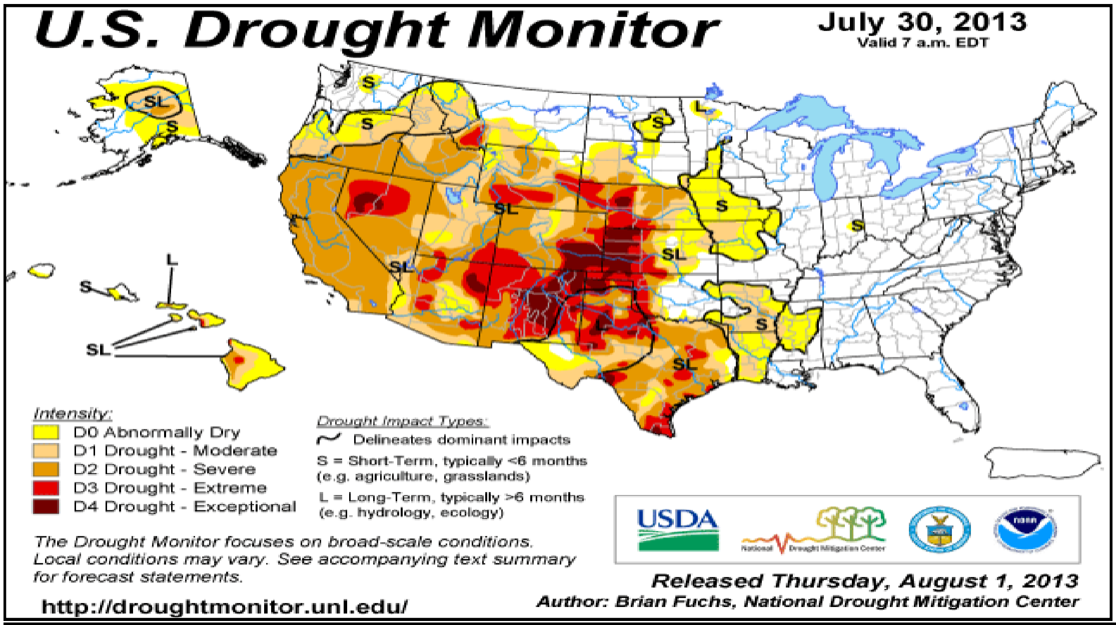
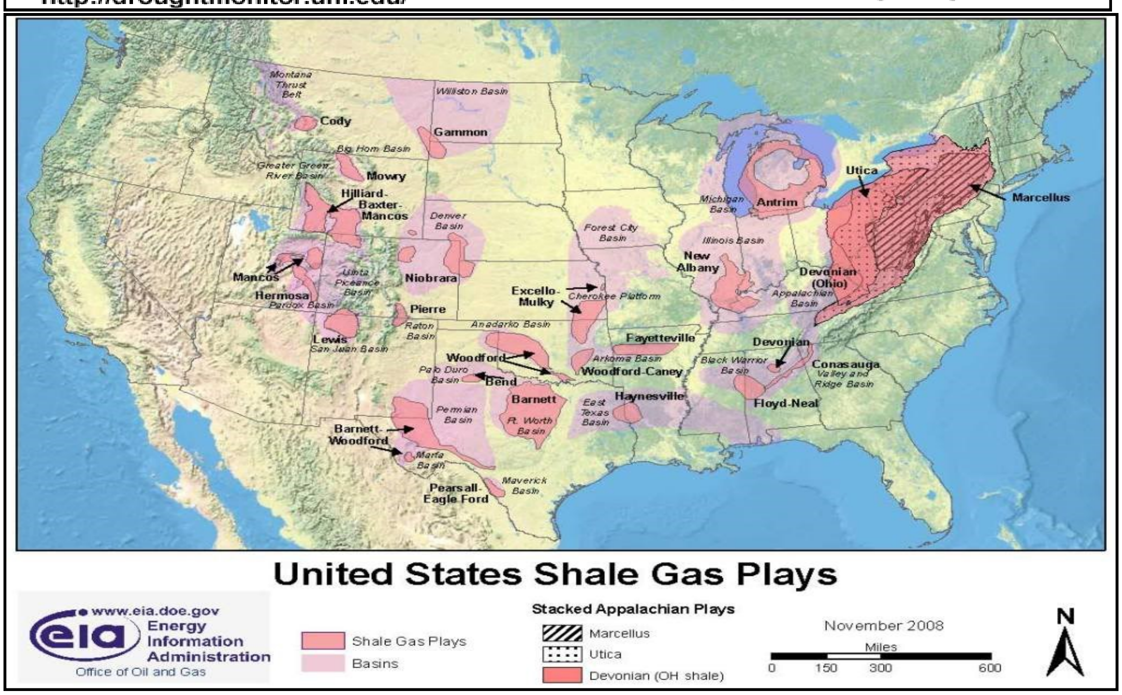
Appendix 2– United States

Drought Monitor

Shale Plays





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September 9, 2013

Disclosures & Disclaimer

Table 4 **Ratings**

Ratings	Count	Percent	Banking Clients in Last 12 Months	Disclosures
Buy	3	75%	0%	None
Hold	1	25%	0%	None
Sell	0	0%	0%	None
Restricted	0	0%	0%	None
Not rated	0	0%	0%	3

Companies Mentioned In this Report

BMI (NR), HD (NR), ERII (NR), GWR.T (NR)

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