From Filling a Local Demand to
Becoming an International Brand:

AN ANALYSIS OF A WATER TECHNOLOGY CLUSTER IN HAMPTON ROADS, VIRGINIA

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EXECUTIVE SUMMARY

The Hampton Roads region faces a constant threat of flooding. This threat is surely not going to wane, and it is possible that the threat will increase over time. As a result, the region, with its member cities and counties, will be forced to make tough and expensive decisions on flood mitigation. Those decisions are likely to involve large monetary investments, both public and private, into physical and human capital to augment flooding resiliency.

The Hampton Roads region has a concentration of labor in industries that are well equipped to provide goods and services to the cluster

Some of this investment is already occurring in the region. Since 2012, there have been several major flood damage mitigation projects funded by the Army Corps of Engineers. The latest is a $34.5 million project designed to widen the beach and reduce storm damage in the Willoughby Spit area of Norfolk. In addition to the millions of dollars being spent on large-scale projects, the individual cities are spending additional money on smaller projects to restore shorelines and modernize storm water drainage systems. Ultimately, a significant amount of investment in flood mitigation is predicted for the region.

The regional demand for water technology products and services has stimulated an entire cluster of business activity. Firms within Hampton Roads and outside the region are stepping up to provide goods and services to fill the demand for products in flood mitigation, adaptation and resiliency. This is not surprising given the current level of regional need and the projection of future need. Regional firms, such as Norfolk Dredging and Cottrell Construction, are heavily involved in coastal projects. Still other regional firms, such as Heard Construction, DAL Construction and Clark Nexsen, are mixing their traditional lines of business with an ever-increasing focus on resilient construction and shoreline protection.

The Hampton Roads region has a concentration of labor in industries that are well equipped to provide goods and services to the cluster. Employment in the industries associated with water technology represented about 6% of total regional employment in 2015. From 2001 to 2008 (just prior to the Great Recession), employment in the cluster grew from 39,000 to 46,000. Cluster employment contracted during the recession to a low of 41,500, but it has grown steadily each year since 2010 and stands at 43,000 as of 2015. Engineering Services represented 12,500 of the 43,000 jobs in the cluster in 2015. Computer System Design and Computer Programming represent an additional 10,000 jobs.

It is important to note that not all of these jobs are directly related to water technology. The job estimates represent employment

in industrial sectors that are needed by the cluster, but firms in these sectors are not necessarily dedicated to just water technology. The goods and services provided by these firms are, however, used by the cluster.

The Water Technology Cluster in Hampton Roads contains a mix of firms in construction, engineering, mapping, environmental consulting and academia. Nonprofits and city employees are also playing an increasing role.

The number of establishments (firms) in the cluster has increased steadily over the last 15 years. About 2,300 firms existed in the cluster in 2004. It has increased each year and now there are approximately 3,300 firms in these industries.

Many of the existing firms in the water technology cluster are headquartered in the Hampton Roads region. Those firms span the spectrum of size from large, publicly traded, regional firms to smaller, privately owned, specialized firms. Additionally, there has been a marked increase in the number of national firms with regional offices in the Hampton Roads area. Those firms include Moffitt & Nichol, AECOM and WSP/Parsons-Brinkerhoff, just to name a few.

Ultimately, the success of any regional cluster is measured by the cluster's ability to export its goods and services around the country or even the world. Silicon Valley and Detroit are good examples. Location quotients are often used to measure the export orientation of any particular industry. Location quotients in excess of 1 suggest that the firms in the industry are likely exporting their goods and services outside the region since employment in the industries exceeds the employment needed to simply supply the local area.

An analysis of location quotients in the various cluster industries suggests the region has a strong specialization (export orientation) in logistics services (2.49), engineering services (2.39), civil engineering construction (1.94) and water and sewer line construction (1.71). However, the region is not specialized in other key industries to the cluster. Environmental consulting (0.42) and industrial construction (0.23) are examples.

The amount of water technology work regional firms are doing outside the region is another indicator of a strong cluster. Hampton Roads firms are successfully competing outside the region for flood- and storm-related work.

An analysis of government contract awards related to Superstorm Sandy found that firms from Hampton Roads were awarded over $12 million in federal contracts from 2012 to 2015. In addition, Hampton Roads–based firms have received over $24 million in federal awards since 2008 from the Army Corps of Engineers, the agency responsible for awarding the vast majority of flood mitigation/shoreline protection contracts.

The region also has a number of regional groups, higher education institutions and nonprofits that could support a water technology cluster. These players are vitally important. They assist in innovation, networking, development of the labor force and the financing of smaller local projects.

Evolving Hampton Roads from a region that has a set of water technology firms to a region with a nationally-known water technology cluster will take a serious commitment from local firms, local cities and the Commonwealth. To that end, we propose the following list of regional needs:

- The creation of a regional water technology trade association. Such associations provide networking among firms in the cluster and help promote the cluster to markets outside the region. The association would also become the "brand identity" for the cluster in Hampton Roads, much like the Milwaukee Water Council has become for the Milwaukee, Wisconsin, metro area.

- A monthly or bimonthly event that brings together the actors in the cluster. This is particularly important since much of the demand for water technology comes from local, state and federal contracts. Some of the smaller, regional firms may lack the scale to effectively compete for these contracts individually (particularly the large federal contracts), but cooperation with another regional firm might give both parties a higher probability of winning the contract. The event would serve as the "meeting place" for businesses, universities and nonprofits increasing the odds of cooperation without forcing cooperation.

- The systematic, ongoing collection and analysis of cluster statistics (like those contained in this report). This is necessary to track the health of the cluster and to uncover any changes to the marketplace. *The Coastal Index* published by The Data Center in New Orleans serves as an excellent example.

- The creation of a water technology research park to facilitate networking among cluster firms and provide a central location for auxiliary firms (legal services, business services, IT) to find and work with the firms in the cluster. This would create a tight connection between the cluster actors and the regional innovation community. The regional firms must move beyond providing services to the marketplace with existing technology. This could be achieved by partnering with other firms, universities and federal labs in producing the next generation of innovation in the cluster.

- An analysis of the role for regional innovation groups such as the Hampton Roads Innovation Collaborative, including a thorough review of policies at universities and labs that affect the commercialization of research and the ability of early stage innovators in the region to attract private and corporate venture capital.

- An aggressive, export-oriented business strategy for the existing firms in the cluster. This will help establish a brand image for the region. This could be accomplished by putting the existing firms in the cluster through the recently developed Regional Export Accelerator Program (REAP).

Hampton Roads has a long way to go to catch up with a region like New Orleans when it comes to the size and strength of the water technology industry. The region should not be deterred, however. Flood mitigation and flood resiliency are two of most important economic issues facing coastal cities in the United States. Additional water technology efforts from the private sector, public sector and nonprofits, throughout the country, are necessary to keep up with the demand that coastal areas are sure to face over the coming years.

INTRODUCTION

Hampton Roads is a region faced with significant water–related issues. Those issues include recurrent flooding from heavy rain, along with tidal flooding and beach erosion from tropical systems. Those issues are forecast to worsen over time as a result of sea rise and land subsidence.

The constant threat of tropical storms and nor'easters has forced the region to develop both physical assets and human capital in and around water technology

Hampton Roads has a tremendous regional need for water technology solutions. Forward–looking measures of flooding risk put Hampton Roads near the top of southeast coastal cities, even when ignoring possible sea level rise. So, cities in the region have a significant need for water solutions. That need, however, does not mean that the region will automatically possess a viable, export-oriented water cluster.

Efforts are underway by municipalities, government agencies and private business to mitigate the negative impacts of these issues. As a result, significant human capital is needed to make optimal decisions under binding budget constraints. Also, innovation is needed to develop and manufacture products that would help with coastal protection, storm water drainage and flood mitigation.

The constant threat of tropical storms and nor'easters has forced the region to develop both physical assets and human capital in and around water technology. This expertise shows up in a variety of places. Many regional engineering firms have coastal engineers on staff. Regional insurers, reinsurers and financial institutions are well versed in the details of construction and development in and around flood-prone areas. Regional universities have made recent and substantial investments in faculty focusing on the many issues surrounding recurrent flooding. Finally, the individual municipalities possess a number of staff with expertise in flood mitigation and adaptation.

What transforms all of those assets into a full-fledged water technology cluster? The answer to that question is the goal of this report. We examine the way in which firms in an industrial cluster can transform their regionally based activity into exportation of its goods and services outside the region (or even outside the state).

In this report, we provide a discussion of clusters and cluster formation as background. We examine a broad set of cluster–related economic indicators to gauge the current strength and future potential of a water technology cluster in Hampton Roads. As a result of that analysis, we conclude that the cluster in Hampton Roads is in the emerging stage. Therefore, we end the report by offering some recommendations for near-term investments that could develop the cluster.

WHAT IS AN INDUSTRY CLUSTER?

Regional economies are complex. Even regional economies with clear identities (like Silicon Valley) possess some amount of diverse economic activity. In order to explain the economics of a region, it is necessary to impose some form of organizing framework. Michael Porter has been the leading proponent of using industrial clusters as such an organizing framework. The concept was designed to move policymakers away from firms and toward clusters of related firms as the unit of interest for regional economic analysis.

A cluster approach minimizes the chance that state or regional incentive programs and other economic development policies become narrow in scope

The cluster approach provides three clear benefits. First, clusters provide a clean, organizing framework for analyzing a complex regional economy. Defining a regional economy by clusters makes measurement of competitiveness more accurate. While certain industries in a cluster might be less competitive, other industries in the cluster might be very competitive against other regions. So, overall, the cluster might be quite competitive. Second, clusters help when it comes to analyzing the workforce needs of a region. An appropriate example would be the difference between analyzing bio-medical firms in Boston versus a bio-medical cluster in Boston. The workforce necessary to support bio-med firms would consist of scientists, doctors, lab technicians and other health–related workers. However, the workforce needed to support a bio-med cluster would include patent attorneys, venture capitalists and engineers. Thinking about bio-med as a cluster provides a more comprehensive view of needed occupations. Finally, a cluster approach minimizes the chance that state or regional incentive programs and other economic development policies become narrow in scope. As with the labor example on bio-tech above, analysis of the bio-tech cluster might reveal broader policy needs that might have been overlooked with an analysis that focused just on scientific firms or hospitals.

Clusters also provide an identity for regional economies, like the auto industry cluster in Detroit or the music cluster in Nashville. The existence of the cluster reduces the need to use economic development incentives in attracting related firms to strong clusters. Firms want to be geographically near the cluster to exploit the economic benefits, since firms in the cluster benefit from each other. This is often referred to as production spillovers. The presence of a production spillover suggests that firms in the cluster welcome, instead of fear, the growth of related firms. Firms in a cluster feed off all of the other firms in the cluster. In addition, the maturation of the cluster will lead to the creation of new firms in the region and the relocation of related firms

to the region with little or no subsidization by development authorities. Ultimately, development strategies will be best served to expand on the region's strengths (as captured by the clusters) rather than randomly choose firms or industries to try and attract.

Cluster analysis will not provide a cure to all that ails a regional economy. However, when performed correctly, cluster analysis can provide important recommendations for the growth of clusters, which should translate to regional economic growth. The key to effective cluster analysis is in the definition of the clusters and the ongoing dialogue between policymakers and cluster members. Therefore, cluster analysis is at its best when it employs both quantitative (data analysis) and qualitative (interview-based) research. This is the approach taken in this paper.

The Importance of Localized Learning Opportunities to Cluster Formation

Just a few regions come to mind when one thinks about water technology knowledge. One such region is actually an entire country - The Netherlands. The Netherlands has been dealing with water issues for centuries. Out of necessity, the Dutch invented, implemented, learned, re-invented, implemented and learned. This process has been going on in the country for centuries. Importantly, this learning process holds for technological inventions as well as services and consulting.

The emergence of the water technology industry in The Netherlands was clearly a result of geographic advantage and localized need. This same phenomenon is pervasive across a number of industries: coffee production in Columbia and rice production in China, among others. Geography is, perhaps, the most important regional endowment. Geography has always played a crucial role in the production of agricultural goods. Some food products are just easier to grow in certain climates. Therefore, certain regions will find themselves highly competitive while others will be unable to compete.

The knowledge economy also contains a number of industries that rely on geography for a competitive advantage. Professional services, business services and technology can all benefit from proximity to a strong client base. Research on venture capital firms suggests the presence of a "home bias" in their investments.[1] So, even in an age when distance from the client is less of an obstacle, many firms still recognize the importance of proximity to their market.

Localized demand will impact cluster development much the same way as geography. Localized need by a region can lead to an industrial cluster in that same region by:

1. Allowing smaller firms in the industry to compete for projects.
2. Allowing existing firms in the industry to develop a portfolio of successful projects.
3. Attracting industry specific human capital to the region.

Small- and medium-sized enterprises (SMEs) comprise the majority of firms in regions outside the major metro areas. These firms often find it difficult to compete for large, federal contracts and private, commercial work outside their region. However, these firms may

1. https://www.researchgate.net/publication/46506920_Local_Bias_in_Venture_Capital_Investments

find their own region a much more friendly environment, thereby securing contracts needed to grow firms over time.

Additionally, as these firms secure regional work in the industry, they are provided with a strong portfolio of projects. Those projects can provide firms with legitimacy as they attempt to expand their market outside their own region.

Finally, a concentration of industry demanders in a region will undoubtedly cause a concentration of industry suppliers to follow. The suppliers, then, have their own demand in the form of labor and capital specific to the industry. In this case, the region becomes known for an industry as a result of its demand for the industry's goods and services instead of its concentration of firms.

Weeks Marine, Inc. in New Jersey provides an interesting example of the importance of localized demand to the successful expansion of a firm. Founded and headquartered in Cranford, New Jersey, the company's early years were spent working in stevedoring in and around the NY/NJ region. After developing industry expertise locally, the company went through a series of acquisitions and now possesses regional offices in Louisiana, Texas, Hawaii and Canada. Along with geographic expansion, the firm also expanded in scope. Weeks Marine now has capabilities in marine and tunnel construction, dredging and salvage. The various regional offices allow the company to continue to capitalize on local demand in each region. As a result, the company routinely wins large flood mitigation contracts in Louisiana.[2]

The next section presents quantitative evidence on the viability of a water cluster in Hampton Roads. While Hampton Roads currently does not possess a mature water cluster, the region does possess capabilities highly related to water mitigation. Existing capabilities such as engineering, storm drainage and sewer line construction, which are currently local serving industries, could be exported to localities with need and a lack of resources. We examine employment, wages, location quotients and current procurement contracts for industries directly related to water technology to provide an overview of existing activities. As a result of this analysis, we conclude that the region is well positioned to develop a mature water technology cluster. We end the report with some recommendations to government, industry and nonprofits that might hasten the development of the cluster.

2. From an analysis of the Louisiana Coastal Protection and Restoration Authority's (CPRA) contract and procurement data.

EMPIRICAL ANALYSIS OF THE WATER TECHNOLOGY CLUSTER IN HAMPTON ROADS

Employment and Wages in the Cluster

In this section, we take a look at a variety of relevant data for determining the viability of a water cluster in Hampton Roads. The analysis of the cluster includes an examination of employment and wages for the industries contained within the cluster. We also provide locations quotients for each sub-industry in the cluster. We close with an evaluation of the export potential of the cluster by looking at the number and dollar value of procurement contracts received by regional firms.

Mature clusters are able to influence employment in related industries due to their sheer size

To begin, we must identify the industries that comprise the cluster. We identified 26 industries that are related directly and indirectly to the production of water technology goods and services. *Table 1* presents an overview of these industries. To be as specific as possible, we identify industries at the six-digit level in the North American Industry Classification System (NAICS). We use the six-digit NAICS level to keep as close to true water management activities as possible. For example, we could use Construction at the two-digit level (its code is 23). After all, companies that build levees, storm drainage systems and pumping systems are clearly doing water management construction. However, total employment in NAICS code 23 would also include residential housing construction and multifamily housing construction, clearly not water management activities. Drilling down to the six-digit level allows us to include NAICS code 237110 (Water and Sewer Line and Related Structures Construction) in the cluster. Employment and establishment estimates associated with 237110 are almost entirely related to water technology activities, therefore, providing a much better estimate.

These industries include manufacturing, construction, engineering, surveying and environmental consulting, to name a few. An accurate representation of infant clusters is a tough task and such is the case with the water cluster in Hampton Roads. Mature clusters are able to influence employment in related industries due to their sheer size. For example, the ship repair cluster in Hampton Roads is a very mature cluster. As a result, some of the employment in business services, financial services and even retail is a function of the employment in ship repair. This will not be the case for water technology in Hampton Roads. In fact, only a small fraction of the observed

TABLE 1

Water Technology Industries and Their North American Industry Classification System (NAICS) Codes

	NAICS Code
Crushed and Broken Granite Mining and Quarrying	212313
Construction Sand and Gravel Mining	212321
Industrial Sand Mining	212322
Water Supply and Irrigation Systems	221310
Industrial Building Construction	236210
Water and Sewer Line and Related Structures Construction	237110
Oil and Gas Pipeline and Related Structures Construction	237120
Power and Communication Line and Related Structures Construction	237130
Other Heavy and Civil Engineering Construction	237990
Asphalt Paving Mixture and Block Manufacturing	324121
Pottery, Ceramics, and Plumbing Fixture Manufacturing	327110
Clay Building Material and Refractories Manufacturing	327120
Concrete Block and Brick Manufacturing	327331
Concrete Pipe Manufacturing	327332
Gypsum Product Manufacturing	327420
Cut Stone and Stone Product Manufacturing	327991
All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	327999
Data Processing, Hosting, and Related Services	518210
Engineering Services	541330
Surveying and Mapping (except Geophysical) Services	541370
Custom Computer Programming Services	541511
Computer Systems Design Services	541512
Process, Physical Distribution, and Logistics Consulting Services	541614
Environmental Consulting Services	541620
Other Scientific and Technical Consulting Services	541690
All Other Professional, Scientific, and Technical Services	541990

employment in engineering, construction or environmental consulting is directly related to water technology, water mitigation or resiliency. So, for the purposes of this paper, we will include all related industries and provide estimates of total employment, total wages and total locations quotients. However, we must recognize that even with the use of six-digit NAICS codes, in some of the industries the share of employment that is dedicated to water technology might be quite low.

Figure 1 presents the total employment in the water technology cluster. Employment reached a peak of nearly 47,000 employees in 2008, contracted to a low of 41,500 by 2012 and has remained stagnant through 2015. Total employment was 43,000 in 2015. The Hampton Roads region has struggled to re-attain employment levels at their pre-recession peak. In fact, as of November of 2016, the region still remains about 3,000 jobs short of its 2008 employment. Employment in industries related to water technology has clearly followed the same trend. In addition, cluster employment strongly contracted during the Great Recession and has failed to recover due to federal spending contractions.

Wages for the cluster have been stagnant since the end of the Great Recession *(Figure 2)*. While wages grew at an annual average rate of 4% between 2004 and 2010, wages for the cluster only grew at an annual average of 1.4% between 2010 and 2015. This is yet another illustration of the economic damage from a moderation in federal spending.

Taking a longer look at overall employment growth in the region and in the cluster *(Figure 3)* shows that overall employment in the region is about 1.3% higher than in 2004, but water technology employment is essentially the same as in 2004. The source of the stagnation is mostly a function of the Professional, Scientific and Technical Services sector. This sector represents the vast majority of jobs in the water technology cluster. It includes legal services, accounting services, engineering services (a significant source of employment in water management) and scientific researchers.

The importance of the Professional, Scientific and Technical Services sector to Hampton Roads' version of the water cluster is astounding. These jobs comprise 80% of the cluster's total employment in our region. Indeed, these jobs are currently defining the type of water technology activity occurring in the region.

As mentioned previously, clusters are region–specific. This applies to the types of clusters that exist in a region as well as the composition of similar clusters across regions. The driving industries behind a water technology cluster in New Orleans will likely be different than those that drive the cluster in Hampton Roads. The existing industries and specializations of the region play a vital role in the evolution of the cluster. To this point, we present location quotients (LQs) for the industries included in the water technology cluster. Location quotients are a measure of regional specialization for the industry. LQs in excess of 1 represent an industry that has a higher proportion of employment in the region than its proportion in national employment. As a result, these industries are typically exporters of their goods and services, and thus drive the gross domestic product of the regional economy.

FIGURE 1

Cluster Total Employment 2004-2015

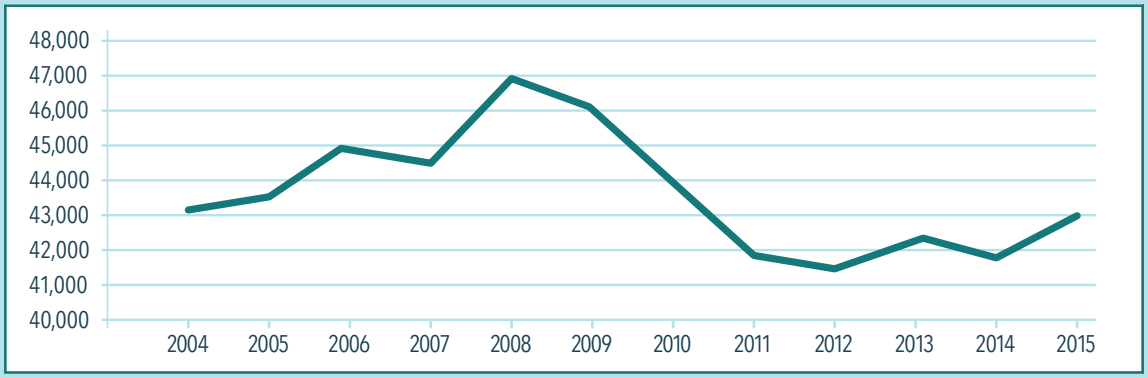


FIGURE 2

Cluster Average Annual Wages 2004-2015

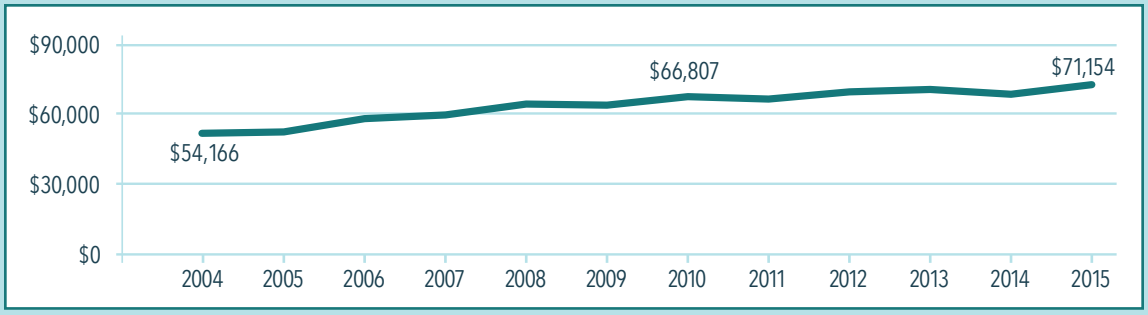


FIGURE 3

Employment Growth
Cluster Employment versus Total Regional Employment *(Index = 100 in 2004)*

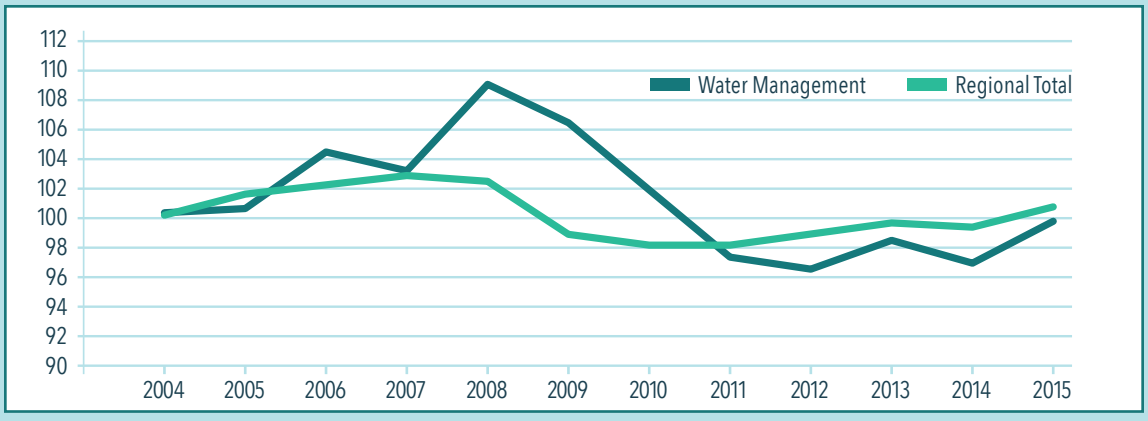


Figure 4 provides the location quotients for 26 of the 29 industries in the cluster (3 industries have LQs of 0). There are a number of industries with LQs in excess of 1. Three industries have LQs in excess of or close to 2: Logistics, Engineering and Heavy Civil Engineering Construction. This is not surprising given the current composition of the economy in the region. We would anticipate that the water technology cluster in Hampton Roads would

FIGURE 4

Location Quotients
(LQ greater than 1 represents greater regional specialization than the nation)

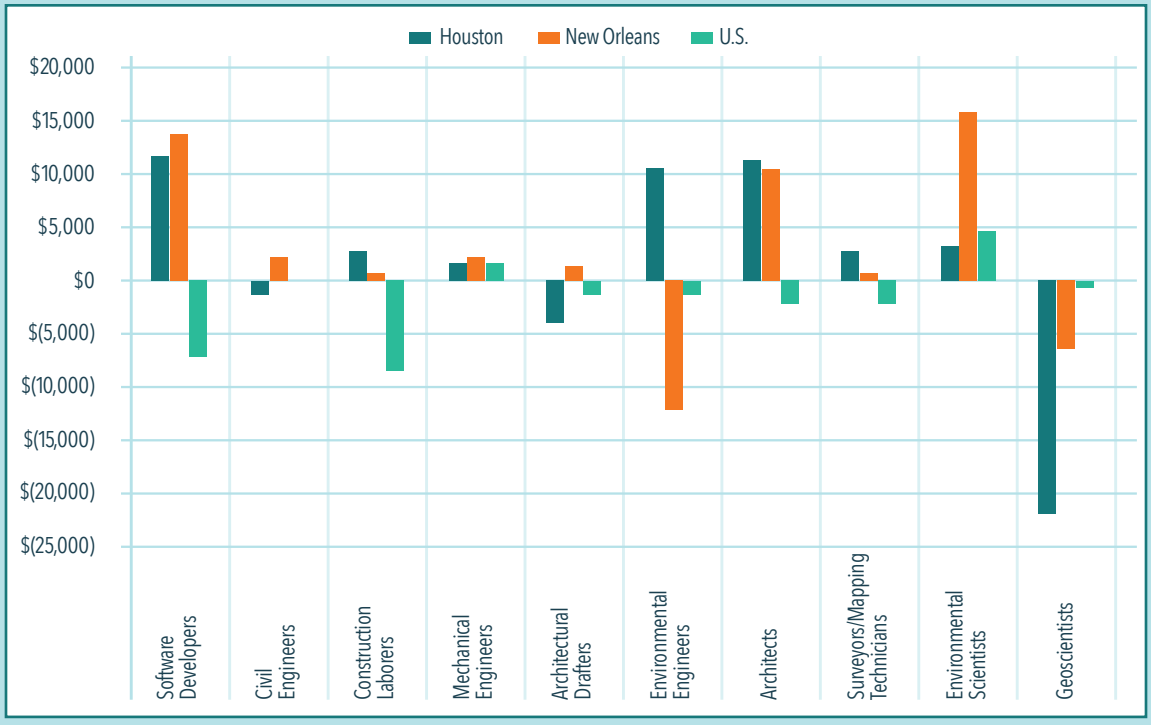
grow and evolve with these three industries playing critical roles, since the region is already specialized in these areas. Examination of the LQs also allows us to think about the industries that the region needs to grow to support the cluster. Hampton Roads has little activity in pipeline manufacturing, which is a major component of flood mitigation and water management. For example, the existing oil industry in New Orleans is often cited as a major reason for the rapid growth of the flood technology industry there.[3]

OCCUPATION WAGES FOR HAMPTON ROADS VERSUS NEW ORLEANS, HOUSTON AND US AVERAGE

Wages are key to attracting and retaining quality workers, regardless of the industry. However, in an aspirational cluster, strong wages are vital since much of the initial labor talent will need to be imported from other regions. *Figure 5* presents the wage difference between Hampton Roads and two existing water cluster cities (Houston and New Orleans). The data presented represent real wage gaps. A positive (negative) number

FIGURE 5

Real Wage Comparisons:
Hampton Roads Occupation-Level Real Wage Gaps Relative to Houston, New Orleans and United States



3. Stephen Picou, "Building Louisiana's Water Cluster," September 2014.

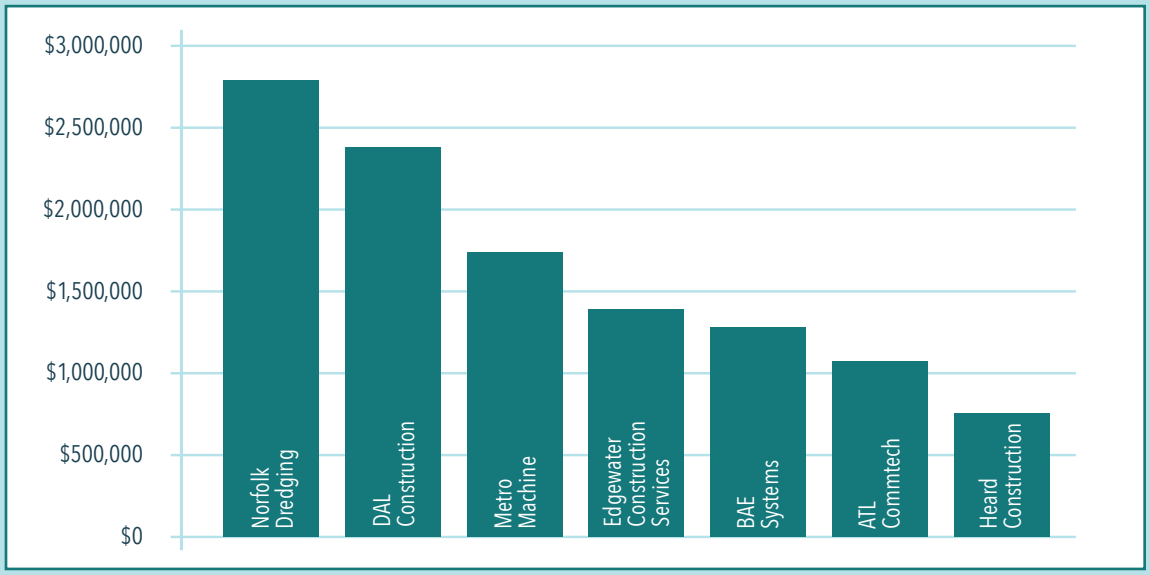
means that Hampton Roads pays more (less) in real terms in that occupation than the other two markets. In most occupations, Hampton Roads wages exceed those in Houston and New Orleans and the region appears particularly competitive for software developers, architects and environmental scientists. Regional wages for geoscientists in Hampton Roads significantly lag both Houston and New Orleans. This is to be expected given the strength of the oil industry in both locations. Against the United States as a whole, the Hampton Roads region fares worse. Regional wages are less than US average wages for all occupations except for mechanical engineers and environmental scientists. Finally, regional real wages in the important environmental engineer occupation are highest in New Orleans (about $12,000 more than HR). Regional wages are slightly behind the US ($1,576), but exceed Houston (by $10,491). Overall, the region appears well positioned to attract talent. While Hampton Roads lags average US wages for many of the occupations, the gaps are small (with the exception of Software Developers and Construction Labor).

GRANTS AND CONTRACTS AWARDED TO HAMPTON ROADS FIRMS

An important aspect of cluster analysis is understanding the ability of the cluster to export its goods and services. Firms in Hampton Roads are doing an ever-increasing amount of water technology work in areas outside of the Hampton Roads region. This "exportation" of products and services is necessary to create brand identity. One way to measure the amount of exports is to examine

FIGURE 6

Post-Sandy Awards to Hampton Roads Firms *(all federal agencies)*
Total Dollar Value *(may include multiple contracts)*



the dollar value of government contracts awarded to regional firms in the aftermath of major flooding events. Figure 6 presents data for Hurricane Sandy awards that were received by Hampton Roads' firms. The figure is not a comprehensive view and only represents the firms with the highest levels of procurement. The various firms provided a number of different services from beach replenishment (Norfolk Dredging), repair and construction on military installations (DAL Construction) to IT network repair (ATL Commtech).

In all, regional firms received over $12 million in Sandy related contracts. This is a good start, but the region has a long way to go. By comparison, the firm of Hammerman and Gainer International (HGI), a third-party disaster administration firm based out of New Orleans, received a $68 million post-Sandy contract alone.[4]

Virginia firms do a great deal of work outside the Commonwealth. In fact, Virginia firms receive a large number of contracts from the Army Corps of Engineers (ACE) outside the Commonwealth *(Table 2)*. According to analysis of 2010-2014 ACE contracts conducted by The Data Center in New Orleans, Virginia was the second largest recipient of out-of-state ACE dollars during the time period, trailing only Illinois. Virginia also ranked second in the out-of-state share of ACE dollars. Regional firms are conducting a decent portion of this work. One example is Norfolk Dredging. Recalling Figure 6, Norfolk Dredging was the largest recipient of post-Sandy contracts. In addition, Norfolk Dredging is a major recipient of out-of-state contracts from the Army Corps of Engineers to undertake dredging for the South Atlantic region of the US. Cottrell Contracting is another regional firm doing a significant amount of work for the Army Corps of Engineers in areas outside the Commonwealth.

TABLE 2

Out-of-State Army Corps Contracts Awarded to Firms in Each State* 2010-2014

State	Out of State Total	Out of State Share
Illinois	$356,753,469	5.53%
Virginia	$198,817,020	2.92%
Florida	$169,454,539	2.56%
Washington	$173,031,897	2.56%
Texas	$150,044,332	2.26%
New Jersey	$141,203,206	2.07%
New York	$105,705,430	1.56%
Missouri	$102,868,128	1.54%
Louisiana	$63,339,080	1.43%
Pennsylvania	$96,059,726	1.40%

Source: *The Coastal Index 2015*, The Data Center, New Orleans, LA.
* Out-of-State Share is calculated relative to the total amount of ACE contract dollars existing outside the relevant state.

4. It should be noted, however, that contract was terminated without a full payout.

THE NEXT CHAPTER IN THE REGION'S WATER TECHNOLOGY CLUSTER

It is evident from the material presented that the Hampton Roads region has a number of existing assets suitable for growing a cluster in water technology. Indeed, a tremendous amount of business activity and scholarship is already occurring. Couple the current activity with an urgent challenge in dealing with recurrent flooding and this provides a solid foundation for a regional cluster. The next step for the region is to turn the nascent cluster into an internationally recognized cluster of firms focused on expanding their market share and therefore exporting their knowledge and innovation to areas outside the region.

Understanding the stage of a cluster is necessary in determining policies that will augment and develop the clusters

Clusters like firms have life cycles. A cluster's life cycle is somewhat dependent on the maturation of the firms contained in the cluster, but the cluster's evolution is more dependent on the networking between related firms regardless of their age and size.

Figure 7 provides a simple model of a cluster life cycle as suggested in Clunet, 2008. Scale is an important part of the evolution of the cluster. More related firms exist in the mature stage of a cluster than in the agglomeration stage. However, the connectedness between firms (regardless of the number) is the true mechanism behind a maturing cluster.

Understanding the stage of a cluster is necessary in determining policies that will augment and develop the clusters. Cluster needs are quite different across the life cycle. Proposing a set of initiatives fruitful for a mature cluster will prove ineffective for an emerging cluster. In *The Cluster Policies Whitebook*, Thomas Andersson and his co-authors describe the nature of a cluster in each stage. At the Agglomeration Stage, the cluster has a number of actors (firms, universities, nonprofits and government) involved in many different aspects of the cluster. However, they are loosely connected and, in some cases, are even directly competing. Essentially, there is no cluster since the actors are not capitalizing off the agglomeration. The cluster begins to evolve to the Emerging Stage once the actors recognize the existence of each other and begin to cooperate around a core activity. The Developing Stage begins as new actors emerge in the space (a grow-your-own effect) and the region is also able to attract firms to the region as a result of significant agglomeration spillovers. Much like the mature firm, the Mature Stage for a cluster is characterized by scale. The cluster is at critical mass, though new ventures, spin-offs and mergers can occur. Finally, the cluster will need to survive innovation, market changes

and competition from other areas. This could require a transformation of the original cluster (Transformation Stage) into an entirely new cluster or a significant change to the way in which the cluster provides the product(s) or service(s).

Where does the water technology cluster in Hampton Roads fall with respect to *Figure 7*? Considering the analysis of location quotients, employment levels and the dollar value of contracts, its seems fair to place it in the Emerging Stage though very close to the Developing Stage. Therefore, what types of policies could accelerate the growth of an emerging cluster?

The irony of discussing cluster-based public policy is that true clusters don't really need policy assistance to succeed. The emergence and growth of the cluster is organic. Cluster analysis, at its best, is not an exercise in picking winners and losers. The cluster's existence means it is already a proven winner and it likely became a winner with little or no public intervention. That said, there are ways in which governments can propose policies or increase the provision of certain public goods in a manner that enhances the strength of the cluster.

To the extent that clusters need a highly educated workforce, public entities could support the cluster by broadly providing resources to higher education or skill-based education without it being directly tied to the cluster's activities. To the extent that clusters need assistance and motivation to cooperate or meet other firms in the cluster, public (or private) entities could hold events to bring the actors together. These events should be open to individuals in any industry within the region and not merely be open to those we think are already engaged in cluster activities. Essentially, the policies should be highly inclusive.

Narrowly focused policies are one of the biggest mistakes public entities can make with regard to cluster growth. Such policies are likely to favor a few over the many. Examples include targeted tax incentives or highly specific workforce development programs. Alternatively, public entities should focus on broad policies that improve the prospects of the cluster, but also improve the growth of regional economic activity that falls outside the cluster. For example, a regional commitment to STEM education, in general, could be as valuable to a water cluster as any targeted water technology initiative.

FIGURE 7

Cluster Life Cycle

To strengthen and grow a water technology cluster in Hampton Roads, we propose the following set of cluster policies and initiatives:

- The creation of a regional water technology trade association. Such associations provide networking among firms in the cluster and help promote the cluster to markets outside the region. The association would also become the "brand identity" for the cluster in Hampton Roads, much like the Milwaukee Water Council has become for the Milwaukee, Wisconsin, metro area.
- A monthly or bimonthly event that brings together the actors in the cluster. This is particularly important since much of the demand for water technology comes from local, state and federal contracts. Some of the smaller, regional firms may lack the scale to effectively compete for these contracts individually (particularly the large federal contracts), but cooperation with another regional firm might give both parties a higher probability of winning the contract. The event would serve as the "meeting place" for businesses, universities and nonprofits increasing the odds of cooperation without forcing cooperation.
- The systematic, ongoing collection and analysis of cluster statistics (like those contained in this report). This is necessary to track the health of the cluster and to uncover any changes to the marketplace. *The Coastal Index* published by The Data Center in New Orleans serves as an excellent example.
- A tight connection between the cluster actors and the regional innovation community. Firms must move beyond providing services to the marketplace with existing technology by partnering with other firms, universities and federal labs in producing the next generation of innovation in the cluster. This will take a comprehensive review of innovation policies and the region's regulatory environment. This might include an analysis of the role for regional innovation groups such as the Hampton Roads Innovation Collaborative, a thorough review of policies at universities and labs that affect the commercialization of research and the ability of early stage innovators in the region to attract private and corporate venture capital.

There is little doubt that water, both too much and too little, continues to be an important factor in the economic fortunes of cities. Managing water is likely to be one of the greatest concerns facing the world's economies over the next century. Here in Hampton Roads, the region is surely going to face tremendous challenges over the next century adapting to life with too much water.

Is it possible to turn this challenge into an opportunity? The answer is clearly, yes. The region has already started working toward a viable water technology cluster, but lags behind other regions in visibility and scale. Moving the region toward a national reputation in water technology will take a concerted effort across government, private sector, higher education and nonprofit entities.

Currently, local governments and nonprofits are acting as the main drivers with higher education institutions getting more and more involved.

It is worth noting that much of the current activity in the region is taking place at a regional level. That is good news for an area that has a tendency to become overly parochial on various issues. The Hampton Roads Planning District Commission recently established a Sea Level Rise Advisory Committee. This adds another regional voice on water technology issues in addition to HRPDC's existing regional committees for stormwater management and coastal resources management. A new nonprofit, RISE, could evolve into the regional product and process innovation hub that the region desperately needs to move the cluster forward. Finally, a two-year pilot project that brought together constituents from private sector, government, military and higher education on resiliency and flooding was just completed.

While the region is slightly behind other regions in terms of brand identity in a water technology cluster, we have all the ingredients to catch up quickly. Coordinating and consolidating the existing resources into one clear regional brand seems to be priority 1 and product and process innovation seem to be priority 1a. Our small but growing network of regional water technology firms can leverage our existing regional need for their products and services to become competitive in the global marketplace. The most successful and identifiable clusters in the US are clusters that are tightly linked to the area's existing assets, resources and needs at the outset. By that logic, a water technology cluster in Hampton Roads seems like an obvious choice.

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