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Achieving the Triple Bottom Line in Local Economic Development:

The Feasibility of a Detroit Great Lakes Water Research Center

Prepared for:
The Detroit Economic Growth Corporation &
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Executive Summary

The conceptual goal of the Urban Great Lakes Water Research Center is to amalgamate academic research, private sector R&D, not-for-profit advocacy, and public policy to advance technology innovation, to achieve economic diversification in metropolitan Detroit.

The conceptual goal of an Urban Great Lakes Water Research Center is to advance technology innovation and streamline policy to achieve market diversification

This report is comprised of several components that support the development of an Urban Great Lakes Water Research Center public-private partnership. First, the report provides an in-depth proposed model of an Urban Great Lakes Water Research Center. Second, the report provides an analysis of the region's current context specific to water technology cluster. It does so by highlighting the salient findings from the market, labor, and demographic analysis, as well as and overview of current Great Lakes initiatives and potential actors throughout the Detroit region. Fourth, the report examines the Detroit Future City Framework through the lens of water technology innovation and it presents an opportunity for an Urban Great Lakes Water Research Center. Based on the previous sections, the report concludes with an opportunity and feasibility analysis of the potential for the creation of public-private partnership to advance the Urban Great Lakes Water Research Center model.

Background and purpose:

Throughout Southeast Michigan and the Great Lakes region various private, non-profit, institutional and public water-related technology centers and organizations are forming. From H2Opportunities in Oakland County, Sustainable Water Works in Tech Town, the Great Lakes Research Center in Houghton, MI, the recently announced $9 million University of Michigan Water Center (Woodhouse, 2012), and the Milwaukee Water Council, each organization is attempting to develop a competitive, niche market in freshwater innovation and technology transfer.

Consequently, the Great Lakes region is poised to develop a high-tech water industry agglomeration. To date, however, Detroit and its metropolitan area have yet to coordinate their efforts to foster greater efficiency in freshwater innovation. It behooves the region to evaluate and pursue a public facilitated university-industry partnership to engage academic researchers, legislatures, and the private sector to streamline permitting and policy that achieves a high degree of freshwater technology transfer in a single, common facility. Through an extensive literature review, national and international case study comparison, interviews, and quantitative economic development methods the report assess

the feasibility of a public-private partnership to develop a center that equally prioritizes job creation, environmental stewardship, and social equity.

Rationale:

Due to common global issues, it is estimated that water as a natural resource, Great Lakes restoration, and associated technology development could provide up to $18 to $31 billion in long-term economic benefits, support 1.5 million jobs, and provide $62 billion in wages throughout the Great Lakes Region (Vaccaro & Read, 2011; Austin, Anderson, Litan, & Couran., 2008). The region is well positioned to enable the development of an Urban Great Lakes Water Research Center for the following reasons:

"... a "go-to" technology transfer and research and development space, located on the most heavily used waterway within the Great Lakes region can serve as an impetus to put underutilized land and buildings back into productive use."

1. Water technology innovation is an expanding market regionally, nationally, and globally, and Detroit is ripe for tapping into the market. As such, the partnership would allow for innovations including renewable energy development (i.e. hydro-kinetic energy and Waste-to-Energy), efficacy in storm-water management, green and blue infrastructure, desalination processes and technology, and low-cost, highly efficient wastewater treatment processes to preserve the Great Lakes and bolster the region economically.

2. The region lacks a "go-to" facility that engages legislatures, academics, and private industry to effectuate positive change at the state and local level. An Urban Great Lakes Water Research Center has the potential to conduct research, monitor, develop, and craft policy to solve current and future threats to the Great Lakes, and enable water-related innovation that is applicable regionally, nationally, and internationally.

3. The region is comprised of an abundance of academic researchers and private industry leaders, venture capital investors and angel funds, public sector advocates to act as cheerleaders, and engaged policymakers for the development of the Center.

4. There are existing gaps and missing elements in the research foci and organizational arrangement of prominent Great Lakes research facilities that must be addressed to experience a high degree of tech transfer and investment.

5. Water-based accelerators and incubators are appearing across the tri-county region; however, a coordinated regional effort has yet to be established.

Taken together, the region, facilitated by the public sector, might consider investigating and analyzing the potential for water-related technology transfer that addresses and fulfills the aforementioned justifications.

Determining the need:

The lack of regional coordination hinders such innovation for local water-based development. Various agencies, including the Detroit Economic Growth Corporation (DEGC), the Michigan Economic Development Corporation, Wayne State University, University of Michigan, and Lawrence Technological Institute have the capacity to facilitate the synergy needed to engender an Urban Great Lakes Water Research Center. In doing so, the City of Detroit could become an internationally recognized water-technology hub.

The creation of a "go-to" technology transfer and research and development space, located on the most heavily used waterway within the Great Lakes region can serve as an impetus to put underutilized land and buildings back into productive use, grow existing businesses, and attract a new industry cluster to the region. As a result of the recently released Detroit Future City Framework and its focus on market diversification and new, innovative infrastructure systems, the DEGC is uniquely positioned to facilitate a partnership, initiate fundraising, and provide gap financing for a physical, common location.

The Urban Great Lakes Water Research Center will foster job growth, preserve the environment, and provide professional and educational opportunities.

In addition to the DEGC, the aforementioned institutions and state agencies invest a significant amount of federal, state, local, and foundation monies on business development and infrastructure improvements to grow existing business operations and attract businesses with high growth potential. Therefore, I intend to examine the benefits, costs, and feasibility of addressing each tenet of sustainable development in initiating the partnership and operationalizing the proposed Center. The Urban Great Lakes Water Research Center as a concept seeks to achieve the following:

- **Job Creation and Regional Economic Growth** – The proposed Urban Great Lakes Water Research Center could position the City of Detroit and the State of Michigan as a leader in water-related research and innovation. The involvement of academic researchers, high-tech start-ups, and business development services has great potential to increase regional R&D, patenting, product development, and commercialization to spur job creation and foster a poly-industrial region.

- **Environmental Stewardship** – The proposed Center addresses environmental policy implications, developing water-related technology, incubating start-ups, and providing seed and early-stage

capital to accelerate patents into commercialization. These technologies would support innovative waste-water treatment processes, storm-water management practices, and renewable energy generation to preserve the Great Lakes and retrofit existing infrastructure that is less resource intensive and has a longer lifespan.

- **Outreach and Education** – The proposed Center will serve as a platform for community engagement and education concerning Great Lakes restoration and water-based innovation. An integral component of the Center is to engage policy makers, scientists, and private industry to streamline processes that more easily facilitate innovation and restoration, while engaging young talent to stay in the region.

In short, the report provides a detailed feasibility analysis of a university, public-private partnership to facilitate and convene the identified stakeholders to create a water technology and research institution that equally prioritizes economy, environment, and equity to achieve sustainable development throughout the metro-region.

Problem Statement

The DEGC is a quasi public-privat non-profit contracted by the City of Detroit to conduct enconomic development, business attraction and retention, and general redevelopment activities within the Central Business District and adjacent neighborhoods.

the DEGC is seeking to identify unique projects that have potential to catalyze significant redevelopment and job creation. Among numerous possibilities, the DEGC is interested in determining the feasibility of an Urban Great Lakes Water Research Center. The DEGC envisions a model that incorporates significant technology transfer and policy-related formulation through a university-industry, public-partnership.

The DEGC is seeking to identify unique projects that have potential to catalyze significant redevelopment and job creation the City of Detroit and the region.

The value of a feasibility assessment for an Urban Great Lakes Water Research Center exists without regard to it being located in the East Riverfront District. DEGC's upper management acknowledges and also believes that if the EDC proved to not be the best vehicle for implementing such a center, the DEGC staff would still be interested in pursuing it. It is the intent of the DEGC to use the Urban Great Lakes Water Research Center to further the organization's mission to promote economic development. The EDC's East Riverfront Project Plan and redevelopment initiative may well provide a unique setting for the facility once it proves feasible and can be established as an entity." But, by no means does it serve as the only implementing entity or Project Area for the Urban Great Lakes Water Research Center.

In addition to the general economic challenges of redevelopment along the East Riverfront, another constraint exists for an Urban Great Lakes Water Research Center public-private partnership is achieving sustainable development through a high degree of water-based technology transfer. Sustainability is an elusive term that takes on various meanings depending on its context. The most globally recognized and often cited definition is "development that meets the needs of the present without comprising the ability of future generations to meet their own needs (The Brundtland Commission, 1987)." Similarly, in an attempt to achieve sustainable development, inherent conflicts arise between equity, environment, and economy (Campbell, 1996). There are trade-offs between each tenet, and the success of a sustainable public-private partnership is dependent upon the balance and equal prioritization of each tenet. Moreover, the City of Detroit's historical manufacturing innovations are closed and monoplized, while the success of the Center is dependent on open collaboration, retention and attraction of youung college graduates, and branding of the region to attract

continuous private technology investment.

In accordance with the Detroit Future City plan and the tenets of sustainable development, it is essential that the Urban Great Lakes Water Research Center strive to achieve specific imperatives. The plan outlines 12 overarching imperatives to guide successful implementation. Of particular relevance to a sustainable Urban Great Lakes Water Research Center are the following:

1. Re-energize Detroit's economy to increase job opportunities for Detroiters within the city and strengthen the City's tax base;

2. Pursue a collaborative regional agenda that recognizes Detroit's strengths and our region's shared destiny;

3. Realign city systems in ways that promote areas of economic potential, encourage thriving communities, and improve environmental and human health conditions (Detroit Future City, 2013).

The DEGC is interested in evaluating the feasibility of high-tech Urban Great Lakes Research Center public-private partnership

Urban Great Lakes Research Sustainability Conflict

In sum, the DEGC is interested in evaluating the feasibility of high-tech Urban Great Lakes Water Research Center public-private partnership that equally prioritizes each tenet of sustainable development and is in accordance with the Detroit Future City Framework. However, many challenges are present for the development of not only a public-private partnership, but also for the achievement of a sustainably developed center. The purpose of this report is to identify a model and a public-private partnership to overcome the challenges at the outset of the initiative and to facilitate the Center's underpinning of a actualizing each tenet of sustainable development equally.

The Center's Proposed Model

"...Detroit has several advantages specific to water innovation that could lead to a water-based agglomeration."

The proposed model of the Urban Great Lakes Water Research Center is predicated on a high degree of technology transfer between academic and/or institutional research, venture capital community, and private industry demand. While this is a theme pursued by many cities across the country, Detroit has several advantages specific to water innovation that could lead to a water-based agglomeration. Detroit and its region are faced with many challenges in the creation of a Center that facilitates water innovation and industry concentration. Consequently, the public sector can play an increasing and entrepreneurial role in facilitating a complex and dynamic partnership to foster the development of a physical innovation and research center.

Introduction

Michigan VC community is growing. The states VC investment saw a one-year increase of 28% between 2011 and 2012.

Despite an abundance of research claiming that the state is emerging as a high-tech hub, in actuality the State lacks innovation as compared to other regions (Samuel, 2010; Duderstadt, Was, McGrath, Muro, Corradini, Katehi, Shangraw, and Sarzynskwi, 2009). Nevertheless, in 2012, the State of Michigan's VC investment saw significant growth (Anglebrandt, 2013) . Similarly, Price Waterhouse Cooper's MoneyTree Report, reported that in 2012 the State of Michigan garnered $232 million in total VC investment with a total of 47 deals. This represents a 28 percent one-year increase in total VC investment across the state. However, much of the investment is coming from the automotive and life sciences sectors (Sanchez, 2013).

Michigan Venture Capital Summary Statistics

	2008	2009	2010	2011
# of VC Firms in Existence	15	16	19	20
# of Investment Professionals	43	44	53	60
Total Capital Under Management	$1B	$1.1B	$1.2B	$1.5B
Average Venture Capital Under Management Firm	$73M	$76M	$74M	$75M
Venture Capital Funds Raised	$173M	$136M	$40M	$181M
Average Venture Capital Fund Size	**$38M**	**$39M**	**$40M**	**$41M**

Note: Data represents venture firms headquartered in Michigan only
Source: Michigan Venture Capital Association (MVCA), 2011

In order to transition and sustainably capitalize on freshwater supply, innovation, and invention, the VC community and private industry must perceive investment as lower risk with moderate-to-high return.

It is necessary to have a private-sector driven approach as the long-term model of any innovation institute.

Therefore, distinct and separate institutional research and human capital must be harnessed synergistically. To do so, the intervention of catalytic innovation enterprises, such as accelerators, incubators, and research councils that achieve oopen innovation is not only sufficient, but also necessary to incentivize VC investment, coordinate research, as well as grow and attract Science Technology Engineering Math (STEM)-based talent in Detroit. Catalytic enterprises are predicated on public-sector involvement as a facilitator towards the creation of a private sector-driven institution. The enterprise must prioritize and focus efforts on achieving investor returns through aggressive growth-enabling tactics for innovative firms, i.e. mentorship, networking, and acceleration (Samuel, 2010).

The need for a university-public-private partnership is pervasive in the development of an Urban Great Lakes Water Research, and ought to be the first and most carefully planned step.

Generally, these catalytic enterprises are publicly- and philanthropically-supported to help venture firms receive high return on investment and spur trends that might otherwise be overlooked or unidentified. These publicly driven technology transfer and venture capital investments have proven highly unsuccessful (Samuel, 2010, Vey, et al., 2010 & Beiri, 2013). Therefore, a paradigm shift in catalytic enterprise formation is necessary to see public-private VC investment work in the long-term and garner water-innovation agglomeration. By allowing the private sector to choose the "winners and losers" it enables a higher success rate. The private sector has its thumb on the needs in the market and is better suited for the purpose than the public sector (Lerner, 2009).

Open Innovation and Public-Private Partnerships

At the outset of the 21st century, however, firms started to abandon the closed innovation model. According to Chesbrough, the two chief factors in the R&D sea change can be attributed to the dramatic rise in the number and increased mobility of knowledge-based workers, and the growing availability of venture capital and angel donation to finance and commercialize ideas that are outside the control of corporate R&D labs (2003).

"Open innovation is based on an abundance of open knowledge that is not confined or restricted to one firm. In the open innovation model, firms do not individually develop and act as proprietors of their intellectual property."

As a result, open innovation is becoming the prevalent form of industry R&D. Open innovation is based on an abundance of open knowledge that is not confined or restricted to one firm. In the open innovation model, firms do not individually develop and act as proprietors of their intellectual property. Instead, firms contribute to and leverage others knowledge and technology, thereby discovering new innovations, while coordinating with a variety of firms, rather than exclusive in-house R&D. Moreover, argues companies that leverage outside innovation to advance their business with their current operations will profit greatly in comparison to companies that rely on controlled R&D (Chesbrough, 2003).

Regional economic development initiatives are beginning to acknowledge

the impact of open innovation. Since the 1980's states are increasingly playing a more active role in developing technological policy for statewide economic development purposes (Mayer 2010). The success of Route 128 in Boston and Silicon Valley in California prompted state policy makers to initiate discussions with state universities as to their role in creating partnerships with top industry representatives. As a result, a high degree of university-industry partnerships, an increasing amount of technology-transfer, and open innovation began to occur throughout the country (Mayer 2010). Correspondingly, states are increasingly investing in higher education infrastructure, enabling university-industry partnership facilities, developing entrepreneurship programs to assist start-ups, increasing access to capital for private investment, and generally encouraging cross-disciplinary, cross-border, and cross-institutional collaboration (Mayer 2010).

Challenges

The need for public-private sponsored research institutes has never been so acute. The path towards clean-tech and water-based innovation poses serious constraints. At the local and state level, current initiatives remain inadequate. States and localities do not have the wherewithal to know or make the necessary investments. Furthermore, market failures prevent firms from investing significantly to create investment economies of scale in clean-tech and water-tech innovations (Duderstadt, et al., 2009). Accordingly, if firms are not capable of capturing all of the benefits, they tend to invest in short-term, low-risk R&D ventures. This paradigm does not bode well, if the ultimate goal for an Urban Great Lakes Water Research Center is both short-term in creating investment momentum and long-term in fostering economic and industry diversification for the region. Therefore, the need for a university-public-private partnership is pervasive in the development and Urban Great Lakes Water Research Center, and ought to be the first and most critical step.

Due to the lack of continuous funding available for early-stage companies, many seek alterntatives in different states and regions.

The region faces several constraints in creating a sustainable investment, innovation, and research strategy and development of the Center as a long-term economic development strategy. Among them are the following:

1. **Inadequate deal flow**

   In order for investment deals to flow, there must be a critical mass of industry investment and private sector presence, as well as a concentration of similar research. Opportunities are generally present, but to uncover such opportunities is typically more work than investors are willing or able to undertake (Samuel, 2010). In the Detroit region, the research is present and VC investment is growing, but private industry demand and presence is neither great enough nor centered in the region to enable adequate deal flow.

2. **Higher costs for early stage investors**

In addition to uncovering or having a critical mass, investors are wary of the higher costs associated with early stage start-ups. Venture capitalists and angel donors are more apt to invest in established, more prominent areas where larger investments are taking place, such as California and metropolitan Boston. In the Great Lakes region, this can be attributed to the lack of deal flow to create water technology inventions. There have been relatively few large, successful deals that garner attention from the VC community. This leads to fewer investments needed to create economies of scale to generate large successes. Coupled with competition from coastal agglomerations, and inefficiencies in Great Lakes water-based investment, the region, despite its knowledge infrastructure and natural resources, will likely remain an unattractive region for investment without a physical space where economies scale in early-stage companies, research and start-ups are taking place (Samuel, 2010).

3. **Discontinuous lead funding**

"The proposed model of the Urban Great Lakes Research Center in Detroit is based on the notion and goal of achieving sustainable development, while creating inventions and high investment returns for private industry.."

Assuming that improved returns are possible throughout the state and region and investment economies of scale are achievable another constraint remains. According to Samuel, "venture investment in the Great Lakes states…" and the State of Michigan "….are presently not large enough to lead to later stage financing rounds (Samuel, 2010)." Start-up firms must have enough investment throughout all stages of development to see the company grow and have the required VC return achieved. As a result, companies must go outside of the state and region to find seed capital and early-stage investment, further exacerbating the flight of companies, investment, and intellectual capital. Successful investment breeds additional investment. As such, if larger venture funds can be created, grown, or attracted to the city and the State, the lack of continuous funding will subside and the region could become branded as a water innovation hub, much like Route 128 in bio-medical and Silicon Valley in high-tech (Samuel, 2010).

The Proposed Model

The proposed model of the Urban Great Lakes Water Research Center is based on the notion and goal of achieving sustainable development by creating water inventions that yield high return on investment for private industries and VCs. To successfully maintain sustainable development practices, while simultaneously pursuing technology transfer and innovation, the Center must

provide service to the community. Therefore the center is characterized by institutional arrangements, interdisciplinary research, technology commercialization, policy formulation, and education and outreach. The Urban Great Lakes Water Research Center is designed to link fundamental water-related scientific discovery with innovation and technological invention through a high degree of R&D that creates the products, processes, and services needed to sustain the Great Lakes, while sustainably serving populations world-wide (Duderstadt, et al., 2009).

The center's theme

To achieve innovation, investment return, and Great Lakes sustainability the Urban Great Lakes Water Research Center is organized around a particular theme: Water innovation and invention. From a regional R&D perspective it is necessary to incorporate a systems approach for technology development (Duderstadt, et al., 2009). In this approach, technology transfer and development transcend the silos and parochialism of institutional research labs and academic research (Richardson, 2012). As a result, research interests and technology advancement specific to water can come together and facilitate an even higher degree of transfer and potential commercialization. This not only diffuses a greater amount of research, but it also creates a technology brand and positive investment perception in the VC community to create in turn a continuous flow of funding (Vey, et al., 2010).

A potential partnership structure

There is a role for the federal government to provide resources and scientific "know-how" in the partnership structure.

The Urban Great Lakes Water Research Center must have an inclusive and accountable partnership structure. Multiple actors are needed and should be tapped for a variety of resources and capabilities, including private industry and companies involved in or able to re-tool for water products and innovation, early-stage entrepreneurs, regional investors, governmental agencies (local, state, and federal levels), and university research labs (Duderstadt, et al., 2009). However, it is crucial that the public sector at all levels only serve as facilitators of the partnership that they do not choose the losers and the winners of the research paradigm (Lerner, 2009; Bozeman, 2000). The needs of the private industry are best known within their own respective sectors (Bieri, 2013). Therefore, the private sector takes the lead in assessing innovative processes and products for commercialization.

In advancing a consistent flow of technology transfer and VC investment, communication between all parties is imperative. A robust partnership could facilitate the necessary communication. How can this be done? Federal labs, such as NOAA, would commit resources, infrastructure, research technologies and talent (Duderstadt et al., 2009). In conjunction with university research and technology transfer offices, this could enable long-term research to be

converted into discovery and invention. In addition, the State of Michigan and the City of Detroit might consider contributing land, physical facilities, and other infrastructure to allow for the development of a physical space. State and local governments can also enact policy and legislation to facilitate demonstration projects, job creation, and incentives for private industry investment. Similarly, research universities can commit faculty, students and staff time, while also providing small business support to small and medium sized businesses and start-ups (Duderstadt et..Al, 2009; Al-Mubaraki & Busler, 2010). In partnership with state governments, research university Technology Transfer Offices can develop IP policies, which shift the paradigm in the way in which technology transfer is done at the university level (Bieri, 2013). Meanwhile, industry provides the directive by dictating the water-based research problems and technology development. Finally, entrepreneurs and the investment community will support technology commercialization through new business formation, investment, and hiring of active post-graduate researchers.

Creation of a network

"Through the creation of a physical space and the architecture of the public-private partnership, as well as the resources afforded by each entity, collaboration should be a maximized."

Inherent in the Urban Great Lakes Water Research Center is the collaboration of a multitude of entities and a variety of sectors. Through the creation of a physical space and the architecture of the public-private partnership, as well as the resources afforded by each entity, collaboration will be maximized. Research groups involved in specific water-related innovation can network with other researchers. Likewise, investors and entrepreneurs could do the same to stimulate deals and capital. Through the exchange of participants conducting regularly scheduled meetings and updates, collaboration can be intensified, thereby, facilitating a flexible and robust university-public-private research agglomeration that addresses the future challenges of the Great Lakes and Detroit's utility infrastructure (Duderstadt, et al., 2009).

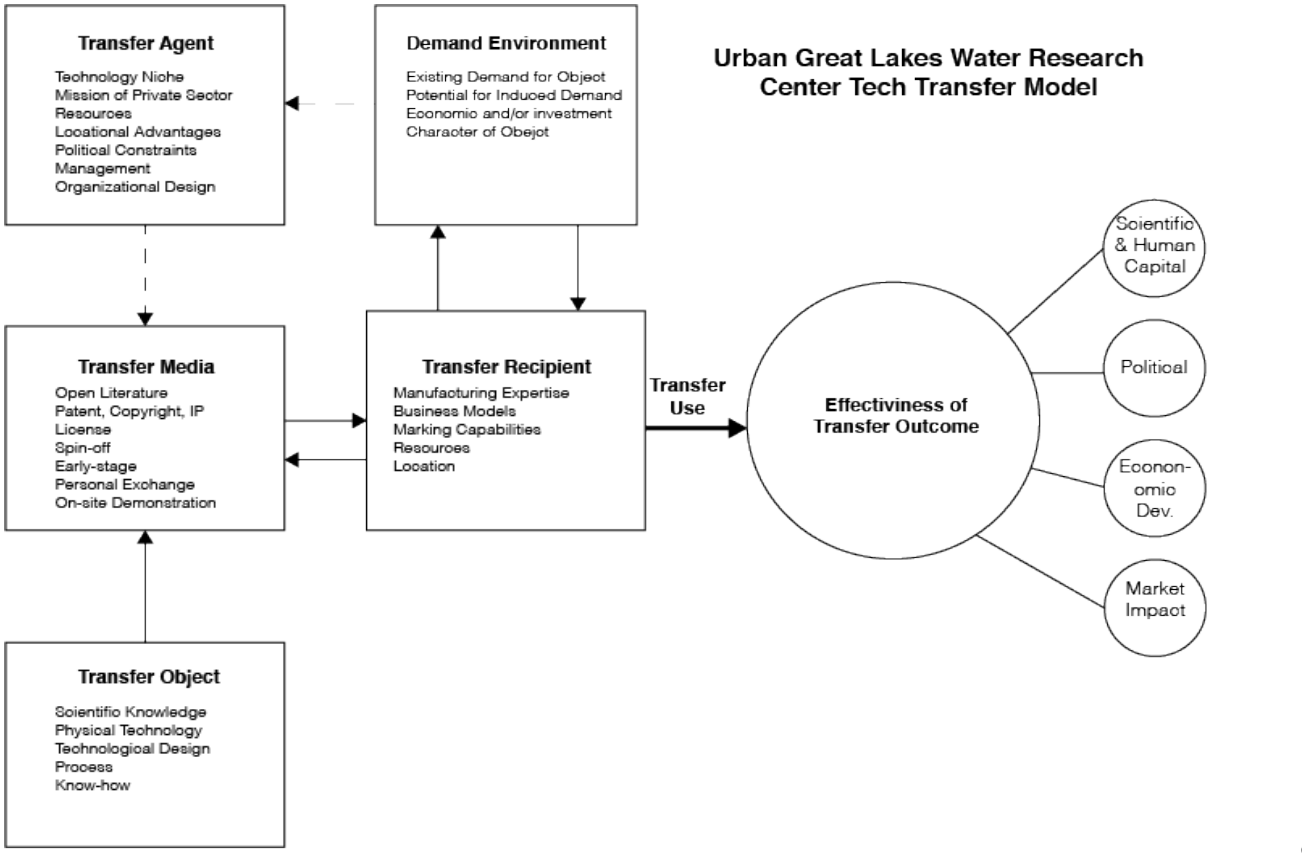
Private sector commercialization strategy

The Urban Great Lakes Water Research Center must be privately led, but publicly facilitated. Once the partnerships are in place, the public sector must stay out of the R&D process. First, the public sector does not know the market. The timing of commercialization is the decision of private industries that know their needs and capacity. Second, the private sector also has a pulse on the necessary size of the center and the intensity of the research. Therefore, the private sector understands the necessary funds needed to catalyze the Center's development. Too often public-sector initiatives are fraught with too little, or too much funding. As a result, the public sector have had little impact on the regions economy (Lerner, 2009). Moreover, the research in question and associated constraints of water technology transfer must be defined by the private sector through their known-how in problem determination (Duderstadt,

et al, 2009).

System for rapid technology transfer and commercialization

The effectiveness of technology transfer is based on the communication of the parties involved throughout the transfer process. The model below depicts how the different agents interact with one another to create specific impacts through water-based technology transfer. Generally, but also in Detroit, the impacts of technology transfer is best understood in terms of who is doing the transfer, how they are doing it, as well as the technology being transferred and for whom (Bozeman, 2000). The model highlights the role of each actor and/or dimension and their function.



Source: Adapted from "Technology Transfer and Public Policy: a Review of Research and Theory" Bozeman, 2000

"The success of the Center is dependent upon the interaction between the effectiveness of all of the agents to enable a continuous VC deal flow."

The transfer agent is the institution of an organization seeking to transfer the technology. This could be government agencies, universities, private firms, as well as the physical characteristics, culture, and organizational structure. Specific to the Urban Great Lakes Water Research Center, the transfer agent is the amalgamation of each entity involved. For example, governmental actors (local, state, and federal) Wayne State University and University of Michigan, and venture capital together comprise the transfer agent. The transfer medium is the vehicle, by which the technology is transferred (Bozeman,

2000). In the context of Detroit, this can be achieved through many avenues, including licensing, copyright, formal and informal contacts, processes, and publications. The transfer object is the actual product that is transferred, such as a technological device, processes, and know-how. The transfer recipient is the organization and institution receiving the transfer object. In Detroit, the recipient ought to be a firm, agency, or organization involved in water innovation. Lastly, the demand environment for the technology is crucial. Private industry must have a need for the transferred object (Bieri, 2013). Market factors that should be considered are the prices for the technology, substitution effects, and advancement of technology that is currently being used (Bozeman, 2000).

Technology Transfer Effectiveness Criteria

Effectiveness	Key Questions
Market Impact	Was the technology transferred and will the technology have a positive impact on a firm's profitability?
Economic Development	Did the transfers lead to regional and local economic development?
Political	Did the technology transfer lead to increased capacity to provide additional resources?

The model presents an organizational arrangement that is necessary to achieve technology transfer, but it does not discuss the purpose or effectiveness of transfer.

As such, what are the characteristics of each agent in the transfer continuum and how can they be best served? For one, the culture of university research is critical (Daniels, 1994). A culture that enables closer academic and professional and/or industry collaboration is imperative. It facilitates the "capitalization of knowledge" and breaks down the proprietary nature of academic work (Erkowitz, 1998). The entrepreneurial academic scientist works in an environment that is industrially relevant, forcing linkages between external industry and R&D organizations. Furthermore, university-government collaborations must not conduct "basic research." The partnership must facilitate research that has a mission with a multitude of foci relevant to market forces and needs as determined by the private sector (Rahm et al., 1988).

The transfer media is also another element that must meet certain characteristics to be effective. The effectiveness of the transfer media is complex and involves a non-linear synergy between all parties. Fundamental to the success of the transfer media is the degree of managerial flexibility,

commitment of collaborating parties, the relationship of the research institute with firms, and the firms ability to absorb and use the technology transferred (Ham & Mowry, 1998). Furthermore, the role of human capital and training is becoming increasingly more important. The use of incubation and resources provided by both university and the private sector are critical (Phillips, 2002). Moreover, it is necessary to involve graduate students involved in water-based research and the relocation of international students (Bozeman, 2000). They can engage in research, possibly move to the region, and provide a robust input system for water technology spillovers.

The role of government in creating a market demand for water innovation through incentives and policies is critical.

The role of government in facilitating a demand environment is also critical. A market failure within the context of the public sector takes on a very different meaning, particularly when using technology transfer as an economic development tool. It is argued that market forces shape demand, however, the public sector through various policies can help shape demand for various technologies. Specifically, that co-funding and the government as a management partner are crucial to effective transfer. Moreover, technology partnerships that are sets of government agencies have a higher incidence of successful transfer (Bozeman, 2000). Accordingly, the role of the federal, state, and local governments is critical.

The overall goal of the model is to have the public sector facilitate the partnership needed to yield high investment return on water-based technology.

The overall model is based on the specific theme of water-based technology development and transfer, involving a variety of sectors. Through interaction of a multitude of stakeholders, researchers, and private sector leaders, creation of investment is fostered and developed. Even though the public sector is best suited for the development of the partnership and to provide additional resources for workforce development, the provision of a physical space, and matching funds for R&D investment, the private sector is best suited for directing the type of research involving water technology. Cumulatively, this would facilitate rapid commercialization and the economies of scale necessary to accomplish political commitment to garner greater resources, market impact and a high return on investment for the private sector, as well as regional economic development encompassing the Great Lakes, water processes, and utility-scale infrastructure.

Profiling Detroit: Current Conditions

Over the past 60 years the City of Detroit has experienced incredible change. Once the thriving backbone of American manufacturing and middle class life, Detroit now stands at a nexus. Between 1950 and 2010, the city lost nearly 60% of its peak population. Correspondingly, property values have decreased at an alarming rate. From 2007 to 2012, property values, as a whole, have a fallen 46% (Macdonald, 2013). While property values are declining, so is the rate at which Detroit residents are paying their property taxes. In 2011, 47% of Detroit households evaded their taxes (Macdonald, 2013). As a result of a declining tax-base, reduction in property value, operating deficits, and tax revenue the City is faced with unsustainable long-term debt. In this adverse environment, the City is challenged to provide minimal residential services.

Detroit's decline and current state is an opportunity to fosters policies for a diversified economy, which is not primarily reliant on the auto-industry.

Nevertheless, not all is gloom for the once thriving industrial city. The resurgence of Downtown and MidTown are exemplary revitalization efforts. The Central Business District (CBD) is experiencing growth in the residential market. Downtown units are commanding $1.65 per square foot (Beal, 2013), resulting from a 42% increase of college educated residents between the ages of 25-34 living in the CBD (Ali, Fields, Hopkins, Olinek, 2013). Within the past year, several companies have moved their headquarters from suburban locales to downtown, the US Department of Transportation provided gap financing for Phase 1 of a 3-mile light rail, and the Detroit Future City Framework was released as a platform to create a more robust, smaller city within its 140 square mile boundary.

However, for the City of Detroit to rejuvenate into a smaller, healthier, and economically diverse city, it must embrace a new paradigm of redevelopment, utilizing its existing assets, natural resources, and its geographic location as a comparative advantage. In capitalizing on the City's comparative advantages, it could alleviate the cost burden of providing public services to a declining population, while stabilizing and attempting to grow the population in the future.

Detroit's Economic and Demographic Profile

The analysis of Detroit's economic and demographic growth trends, industry specialization, higher education patterns in Science, Technology, Engineering, and Math (STEM), and regional venture capital investment shows there is potential for Detroit and the region to become a water-innovation hub. Yet, there still are significant barriers. Likewise, the Detroit Metropolitan Statistical Area

(MSA) , comprising the tri-county region, as an economic leader compared to its RustBelt contemporaries, is waning. As of 2010, the population of Detroit residing within the city limit was 713,777, with an MSA population of 4.3 million (7.2 Acres, 2013; US Census Bureau, 2010). This translates into a -4% population change from 2001. In total, the region contributed $199 billion to the nation's 2011 Gross Domestic Product (GDP), representing the 14th highest MSA GDP in the United States (Bureau of Economic Analysis, 2013a).

Rust Belt MSA Population and Gross Domestic Product Change (2001 to 2011)

Rust Belt MSA's	Est. 2011 Population	2001 Population	% Change	2011 GDP (in millions)	2001 GDP (in millions)	% Change	MSA Rank
Detroit MSA	4,292,060.00	4,452,557.00	-4%	199,378	183,222	9%	14
Cleveland MSA	2,077,240.00	2,148,143.00	-3%	106,810	83,939	27%	27
Pittsburgh MSA	2,356,285.00	2,431,087.00	-3%	117,845	86,131	37%	22
St. Loius MSA	2,787,701.00	2,698,687.00	3%	132,029	97,659	35%	21
Buffalo MSA	1,135,509.00	1,170,111.00	-3%	45,888	32,930	39%	56
Philadelphia MSA	5,965,343.00	5,687,147.00	5%	353,323	241,831	46%	7
Baltimore MSA	2,710,489.00	2,552,994.00	6%	148,256	95,869	55%	19
Milwaukee MSA	1,555,908.00	1,500,741.00	4%	87,539	63,986	37%	35

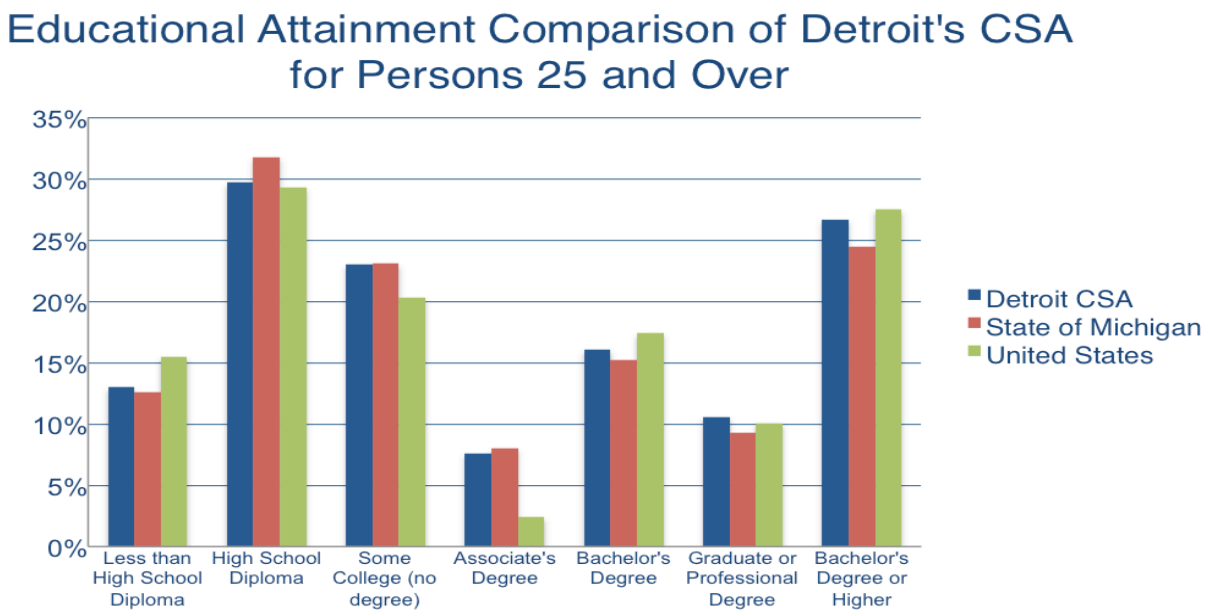
Note: GDP is in millions of $'s
Source: US Census Bureau & US Bureau of Economic Analysis

Detroit's MSA currently is near the top in population and GDP, however, changes in both population and GDP are lowest of similar MSA's.

When comparing the Detroit MSA to similar MSAs based on geography and historic industrial patterns, the only other MSA that produced a higher GDP between 2001 and 2011 was the Philadelphia MSA (Bureau of Economic Analysis, 2012). It is worth noting, however, that while the Detroit MSA contributes significantly to the nation's production, other comparable MSA 's GDP percent change between 2001 and 2011 are increasing at a much higher rate (Bureau of Economic Analysis, 2013 & 2013a). For example, the Detroit MSA's GDP growth was only 9% as compared to 27% and 55% growth in other Rust-Belt MSAs. Furthermore, Detroit's population, as compared to other MSAs, also fares well but is declining rapidly. The St. Louis MSA, Buffalo MSA, Philadelphia MSA, Baltimore MSA, and the Milwaukee MSA experienced population growth ranging from three to six percent between 2000 and 2010 (US Census Bureau, 2011 & 2000). This indicates that while the Detroit MSA is currently prominent throughout it's Rust Belt contemporaries, the Detroit MSA is declining in population and its GDP growth rate is less than any other Rust Belt MSA.

Detroit's Intellectual Capital

The Detroit Combined Statistical Area is a highly educated region. When comparing the Detroit CSA's (a 7-county region) population of 25 and over to



Source: Author's calculations; US Census Bureau

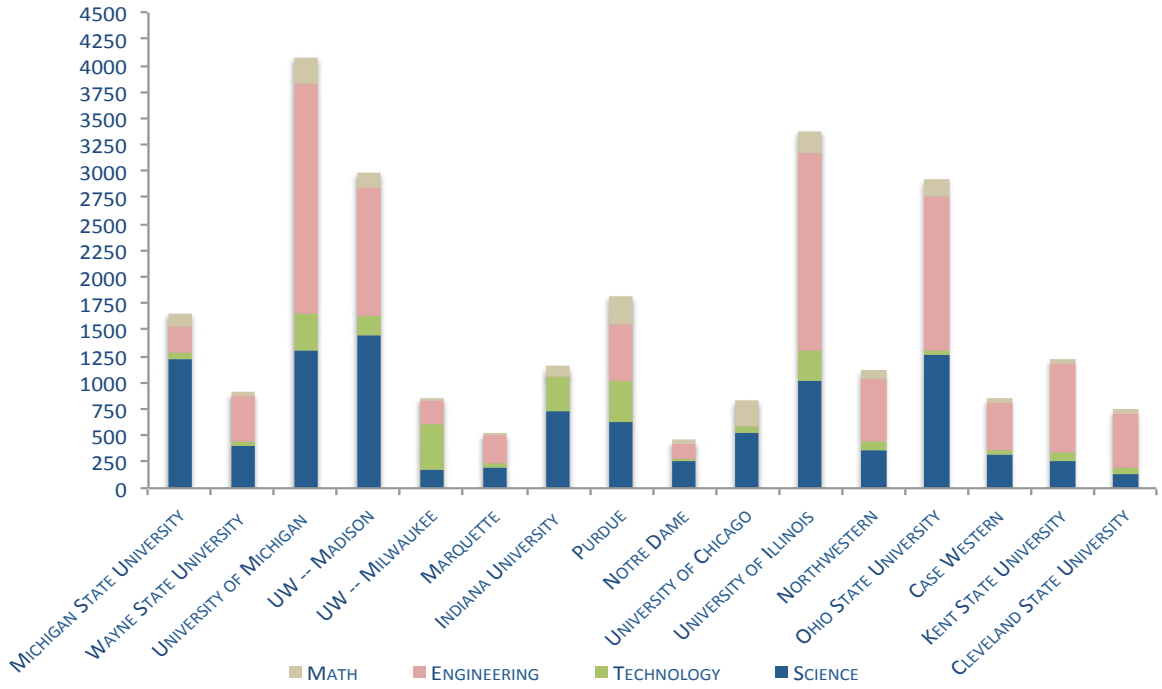
The State of Michigan's universities are leaders in graduating science, technology, engineering, and math students.

The State of Michigan, the Detroit CSA comprises over 15% of the population with Bachelor's degrees, where the State of Michigan, is just under 15%. Moreover, 27% of the Detroit CSA's population has at least a Bachelor's Degree or higher, which is just under the national percentile and 4% higher than the entire state (US Census Bureau, 2011a).

In addition to the Detroit CSA being a well-educated region, it is also produces the highest amount of STEM graduates throughout the Great Lakes region. Choosing Wayne State University, Michigan State University, and the University of Michigan for their relationship as the "Research Corridor" designated by the State of Michigan, they graduate 6,650 STEM grads annually. This translates into 26% of all STEM graduates in the Great Lakes region, which includes 15 land grant universities. In 2011 combined, Michigan universities awarded nearly 3,000 science-based Bachelor and Master degrees, 470 technology-based Bachelor and Master degrees, nearly 3,000 engineering Bachelor and Master degrees, and 440 math-based Bachelor and Master degrees (IPEDS, 2011).

Moreover, the University of Michigan alone graduates 1,100 more STEM students than University of Wisconsin, approximately 750 more than Northwestern University, and nearly 1,250 more than the Ohio State University (IPEDS, 2011). Coupled with population loss, this reveals that Michigan's "Research Corridor" produces a significant amount of talent that leaves the region for more opportunities. However, if the region created more opportunities for meaningful research and work, the out-migration might subside and the trend might reverse.

STEM College Graduates by Great Lakes Universities (2011)



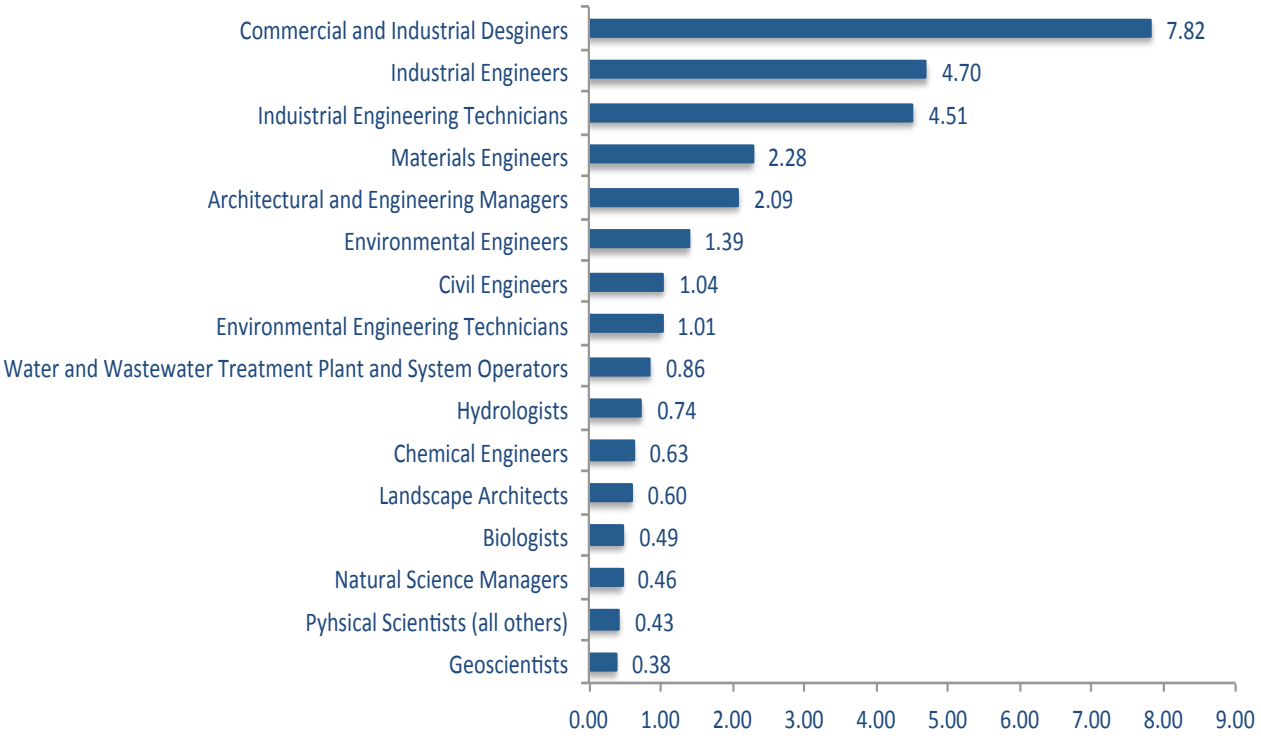
Source: Authors calculations; Institute of Post-Secondary Education Series (IPEDS), 2011

Detroit's Industry and Occupational Specialization

The Location Quotient (LQ) is an economic method to determine occupation or industry competitiveness and/or specialization as compared to a specific base area. To understand the occupational LQ, if the LQ is less than 1.0 it means that the occupation supply is not meeting the demand for that occupation throughout the region, and is considered non-basic. If the LQ is equal to one that means the occupation is meeting the exact demand for that occupation, and it is considered basic occupation. When the LQ is greater than one it means that there is more employment per demand, meaning that the occupations or goods created must be exported, and the occupation is a basic occupation.

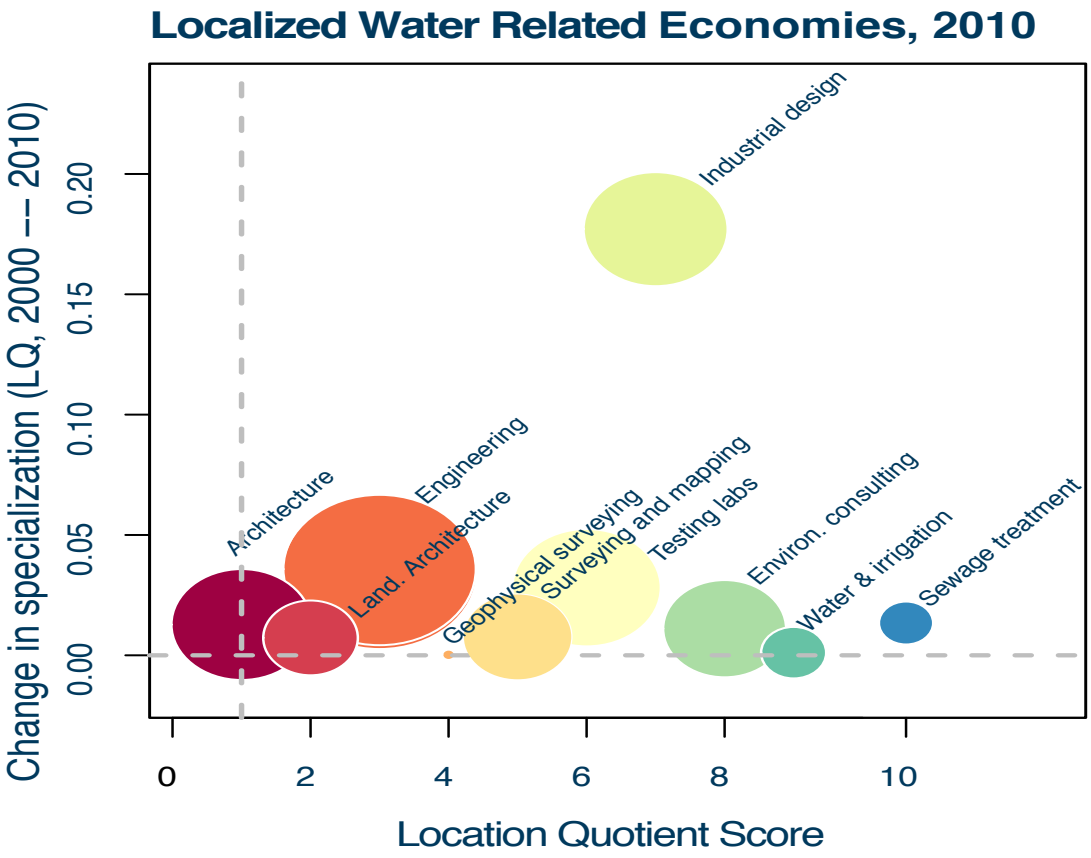
The Detroit MSA occupation LQ is compared below to the national employment of water-based occupations to understand how the Detroit MSA's STEM-related industries and employment compares to the nation. The LQs reveal that the Detroit MSAs is highly specialized in STEM employment, specifically related to the automotive sector, while civil and environmental engineers are also a niche employment sector for the MSA when compared to the nation as a whole.

Location Quotients for 2010 STEM Occupations in the Detroit MSA



Source: Author's calculations; US Census Bureau, County Business Patterns

Specific to the automobile sector, the Detroit MSA, in particular Commercial and Industrial Designers and Industrial Engineers, are highly specialized and unique to the region. In addition, Material Engineers, Civil Engineers, and Environmental Engineers are also highly specialized. Accordingly, Detroit's STEM employment is well positioned to develop a water innovation sector, although significant efforts in workforce and professional development are needed to transition auto-sector designers and engineers into water-based innovation (Austin, 2013).

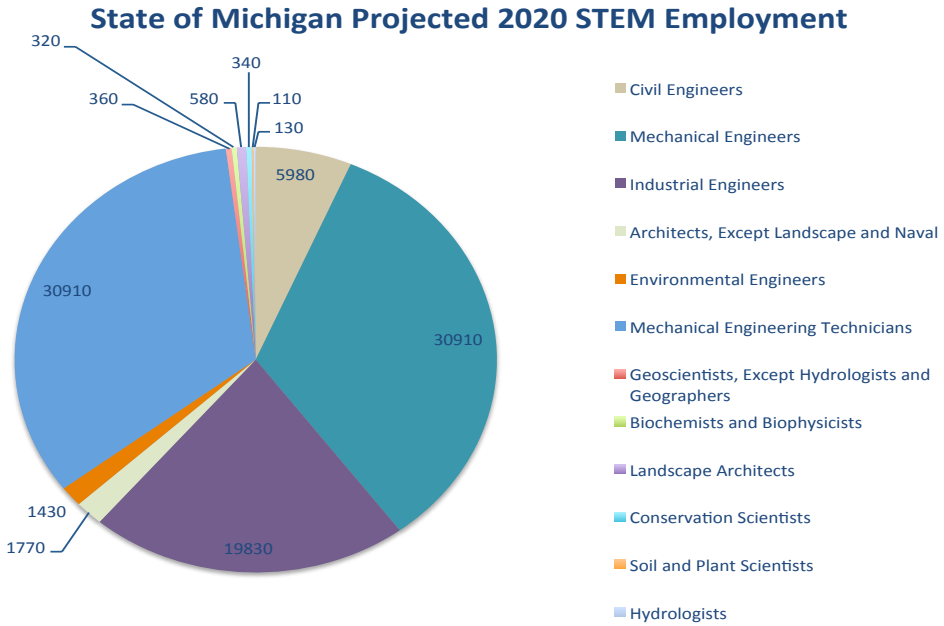


Source: Author's calculations; US County Business Patterns

The chart above provides a detailed look at LQ's for the Detroit region's water-related industry specialization, including the share of jobs within each industry and the rate of change from 2000 to 2010. The size of the bubbles represents the share of jobs within that industry in the Detroit MSA. Noted by the dashed lines, each quadrant shows the industry specialization and rate of change. The upper left quadrant represents industries that are currently specialized, but are becoming increasingly more competitive in the Detroit MSA when compared to the nation. Therefore, industries located in this quadrant are becoming more competitive and should be targeted with resources and assistance from the public sector. The upper right hand quadrant contains industries that are specialized and continue to experience growth in the Detroit MSA. These industries are dominate industries in the region and are increasingly specialized as compared to the nation. The lower left quadrant shows industries that are not competitive or specialized in the region are on a continual decline. The lower right quadrants portray industries that are highly specialized, but over the ten-year period have lost specialization in the region.

The Detroit region has significant specialization and agglomeration of water-based industries. Specifically, Industrial Design, Engineering, and Testing Labs are highly specialized, while Architecture and Landscape Architecture are becoming increasingly specialized over the period in question. However,

Water and Irrigation and Sewage Treatment are specialized, but have lost prominence during 2000 to 2010.



Source: Author's calculations; Bureau of Labor Statistics & SOM Labor Market Information

Furthermore, Detroit's concentration of STEM-based employment is expected to continue to grow throughout the next 30 years. Specifically, Mechanical Engineers, Civil Engineers, and Industrial Engineers are expected to grow, while all other industries are on pace for steady employment. This is notable because many of the engineering fields that are stable and growing can be re-tooled or transition into start-ups, inventing products that could improve industrial water processes, materials for water utility services, and designs for a variety of different types of blue and green infrastructure typologies.

An Overview of Current Great Lakes Initiatives

The State of Michigan is comprised of numerous entities involved in Great Lakes restoration, water-based renewable energy generation, Great Lakes policy, technology transfer, and VC investment into alternative energy and industrial processes. Such a diversity shows promise for economic diversification throughout the region. It also signals a critical need for a streamlined, "one-stop" shop for water technology innovation.

Currently, several universities, NGOs, think tanks, governmental units, and VCs operate in silos across the region and state. Consequently, the collaboration and synergy needed to retain STEM graduates and create investment economies of scale to attract VC and angel investing is hampered (Samuel, 2010). Therefore, water innovation at its current state is latent;

however, the numerous entities involved in Great Lakes research, policy, and investment have the potential to market the region as a water innovation hub to create continuous deal flow and angel investment.

Below is a synopsis of applicable research institutions, current Great Lakes initiatives, governmental entities, VC firms, and angel investors that might consider playing a role in the development of an Urban Great Lakes Water Research Center. The purpose of the synopsis is two-fold: (1) identify current initiatives and research, and (2) propose stakeholders for the development of an Urban Great Lakes Water Research Center.

State of Michigan University Labs and Institutes

The University of Michigan is a hub for water research , policy formulation, advocacy, and sustainable technological advancement

The primary Lower Peninsula public institutions involved in water innovation are the University of Michigan, Wayne State University, and Lawrence Tech. Each institution is unique in the research being conducted, which inherently makes for a robust research partnership. Collectively, the applicable institutes, laboratories, and research centers are the backbone of water-technology innovation and the development of an Urban Great Lakes Water Research Center.

University of Michigan

Environment and Sustainable Technologies (EASTlab) – Mechanical Engineering

Initiated in 2000, EASTlab specializes in the design of technology systems that reduce environmental impacts while advancing economic and societal objectives (EASTlab Website, retrieved March, 2013). The program specializes in the design of water treatment processes, and development of policy instruments and corporate strategies that enable environmentally beneficial products to succeed in the market place (EASTlab Website, retrieved March, 2013).

Erb Institute for Global Sustainable Enterprise

Each entity or institution at the University of Michigan could play a pivotal role in a public-private partnership for a Great Lakes technology Center

The Erb Institute at the University of Michigan is committed to creating a socially and environmentally sustainable society. For over two decades, the Institute has conducted groundbreaking research in sustainable innovation, entrepreneurial activity, and commercialization. Together, the Institute is tailored to combine entrepreneurship, sustainable development, and market-oriented production to find solutions to pressing environmental challenges.

U-M Water Center: Graham Environmental Sustainability Institute

Created in 2012, the recently announced Water Center's main focus is to preserve and enhance sustainable freshwater ecosystems through improved restoration science, policy, and transfer of knowledge and best practices (UM Water Center website, retrieved March, 2013).

Office of Technology Transfer

The Office of Technology Transfer at the University of Michigan is one of the nation's leading developers of technology for economic development purposes (Office of Tech Transfer website, Retrieved March, 2013). Investment is not limited to one set of technologies; rather, the office is diverse in its funding portfolio, spanning from water to bio-medical to information technology (Office of Tech Transfer website, Retrieved March, 2013).

In order to have a robust center the direction and engagement of U-M's Office of Technology Transfer is acute.

Marine Renewable Energy Laboratory

The Michigan Renewable Energy Lab is committed to developing technology to harness clean and renewable marine energy in an environmentally sustainable and low-cost way. The lab designed, invented, and patented the VIVACE Converter, which mitigates any underwater turbine-related effects on marine life.

Wayne State University

Sustainable Water Delivery Department: College of Civil and Environmental Engineering

Contracted by the Great Lakes Protection Fund in 2008, the Sustainable Water Delivery Department in conjunction with the University of Dayton and an environmental engineering firm are creating monitoring technologies to determine the optimal energy usage and emissions for electricity and water utilities (WSU website, retrieved March, 2013). The team has developed a model that informs the timing of service delivery to reduce energy and emissions, while still providing the same amount of power and pressure, respectively.

In addition to the University of Michigan, Wayne State University offers an abundance of research potential with faculty and students alike.

Urban Watershed Environmental Research Group (UWERG) – College of Civil and Environmental Engineering

A multidisciplinary research group housed in the Department of Civil and Environmental Engineering, its main focus is water-related ecological, economic, and human health issues that persist throughout the southern Great Lakes basin (WSU website, Retrieved March, 2013). The applicability of the group's research falls into several themes, including pollution monitoring and impacts, invasive species, and drinking and recreational water.

Great Lakes Law Center – Law School

The Great Lakes Environmental Law Center is committed to developing and advocating for legislation and policy that advances the restoration and preservation of the Great Lakes basin. More specifically, the Law Center focuses on bi-national accords, the Great Lakes Restoration Initiative, and the effects of Climate Change, and how each factor affects the City of Detroit (Great Lakes Law Center Website, Retrieved March, 2013).

Lawrence Tech

Great Lakes Stormwater Management Institute

The vision of the institute is to be an exemplar in providing regional resources for policymakers, designers, and engineers by monitoring of various types of material composition and technologies. According to the head of the program, the institute is one of only several stormwater management monitoring research centers in the nation (Carpenter, 2012).

Governmental Organizations and Research Labs

NGOs are a critical component for policy engagement and legislation at any level. Specific to an Urban Great Lakes Water Research Center, the policy component is a unique feature of national university-industry partnerships (Read, 2012). For many water-based inventions, demonstrations are an essential step in commercialization. Engaging NGOs at the outset will facilitate efficacy during permitting and fulfillment of specific regulatory requirements at national, state, regional and local levels.

Specific to an Urban Great Lakes Water Research Center, the policy component is a unique feature of national university-industry partnerships

International Joint Commission (IJC)

The International Joint Commission (IJC) is an international organization created by the Boundary Waters Treaty, signed by Canada and the United States in 1909. (IJC Website, Retrieved March, 2013). The role of the Commission is to identify, prevent, and resolve disputes and create bilateral agreements between both the United States and Canada involving the St. Lawrence Seaway. In addition, the IJC prepares reports on the state of the Great Lakes and identifies emerging issues in which both countries can engage and pursue.

Great Lakes Restoration Initiative

The GLRI was established in February 2009 when President Obama proposed $475 million for Great Lakes restoration efforts. The GLRI is administered by the U.S. Environmental Protection Agency (EPA) in collaboration with 15 other

federal agencies and is focused on reducing toxic contamination, combating invasive species, protecting wildlife habitat and promoting coastal health (University of Michigan Water Center Institute Website, Retrieved March, 2013).

Great Lakes Advisory Board – Environmental Protection Agency

As a means of implementing the Great Lakes Restoration Initiative, the EPA recently announced the creation of a Board to provide expert recommendations to the federal Inter-agency Task Force (EPA Press Release, March, 2012). The Board is comprised of cross-sector leaders and organizations throughout the Great Lakes region.

Water-based research labs and governmental organizations are the key to bridging institutional research and engaging the legislature at the outset of research innovation

Great Lakes Environmental Research Laboratory – National Oceanic Atmospheric Association (NOAA)

A full service extension research laboratory for NOAA located in Ann Arbor, MI, the Laboratory conducts ecosystem research and provides forecasting of the Great Lakes basin. In addition to internal research, the Great lakes Environmental Research Laboratory partners with several collaborators to monitor harmful invasive species and develop models and forecast the interconnection of physical, biological, and ecological processes. (Great Lakes Environmental Research Laboratory, NOAA, retrieved March, 2013).

Center for Excellence for Great Lakes and Human Health – National Oceanic Atmospheric Association

As a partnering research center of the Great Lakes Environmental Research Laboratory, the Center of Excellence for Great Lakes and Human Health research focus is on three priority areas: beach closures, drinking water quality, and harmful algal blooms (CEGRLHH, Website, Retrieved March, 2013). The research specifically provides forecasts of water quality to reduce negative impacts and risks related to recreational and human consumption throughout the Great Lakes River basin (CEGRLHH, Website, Retrieved March, 2013).

State of Michigan Innovation Organizations

The Detroit U.S. Patent Office, H2O Opportunities, Sustainable Water Works, and the Michigan Economic Center are key NGOs and innovation priority partners.

Innovation-based organizations are key to aiding the R&D process and branding the region as a hub for water innovation. The following are the key actors and/or stakeholders for the development of an Urban Great Lakes Water Research Center.

US Patent and Trademark Office – Detroit Branch

As a result of The America Invents Act (AIA), the federal government has

mandated the US Patent and Trademark Office to establish at least three satellite branches throughout the country. The Detroit office is tasked with increased outreach, improved retention, and recruitment of patent examiners, thereby alleviating the cumbersome process of patent application and increasing the quality of patent examination (USPTO website, retrieved March, 2013).

H20 Opportunities

H20 Opportunities is a non-profit company, which seeks out national and international patented wastewater technology companies to accelerate their invention into commercialization (Ridgway, 2012).

Sustainable Water Works

Sustainable Water Works is an innovative incubator of water-based technology advancement for early-stage start-ups. Comprised of industry leaders in academia, business, and organization dynamic innovation. Sustainable Water Works focus is three-pronged: blue leadership, business forum, and innovation factory (Richardson, 2012).

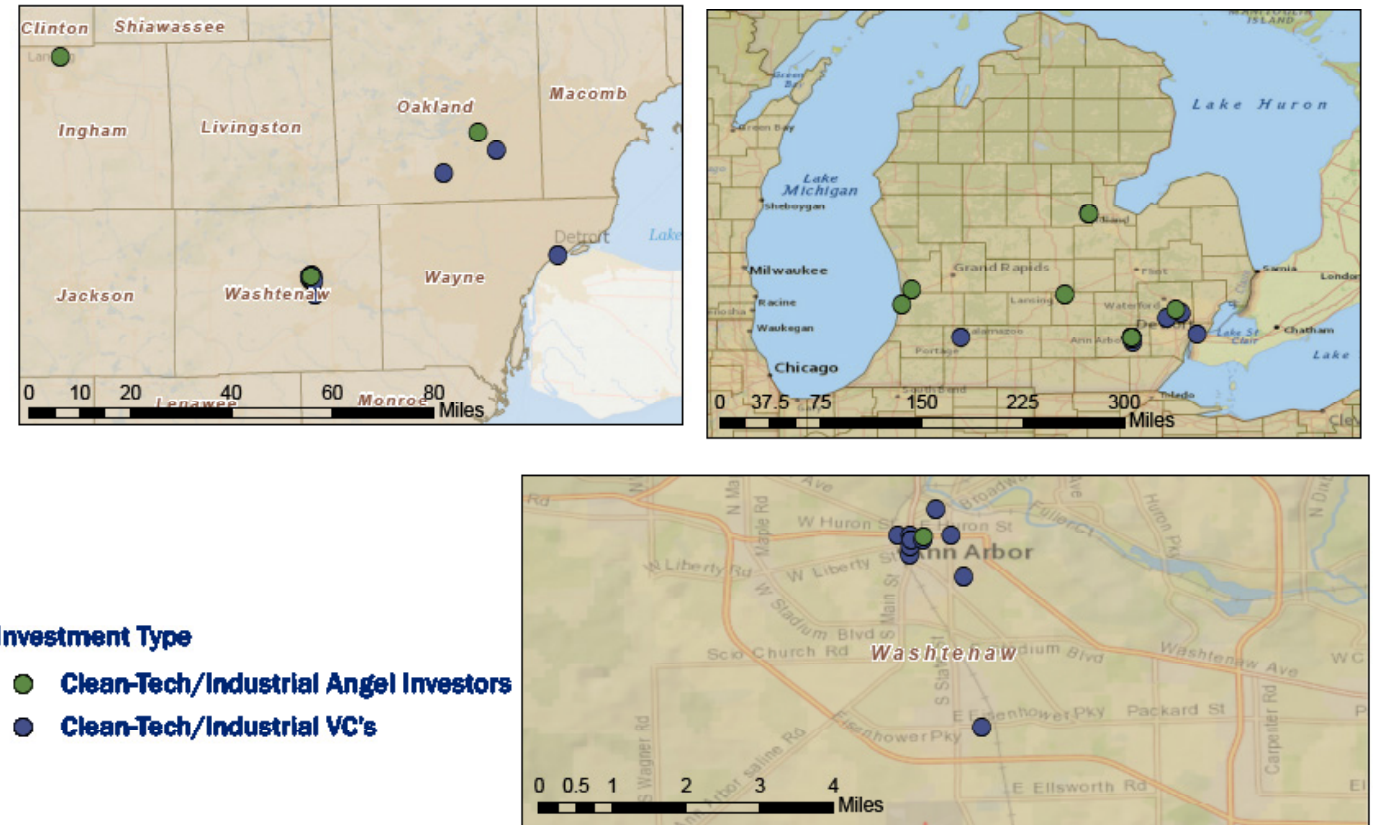
Michigan Economic Center

The Michigan Economic Center strives to advance the vision of Michigan's economic renewal, advocate and develop various policy solutions to stimulate economic development in Michigan, and engage a diverse network of stakeholders (Michigan Economic Center website, retrieved March, 12, 2013).

Michigan's Venture Capital Community

Of Significant importance, is a critical-mass of private-industry demand for specific innovation and R&D (Bieri, 2013). As described in an earlier section, the State's venture capital is increasing rapidly; particularly, in the Ann Arbor and the Detroit Metropolitan Statistical Area. True to agglomeration literature, the venture capital community are locating in very close proximity, fostering an agglomeration of sorts (Porter, 2009). Specific to water, the State's venture capital community portfolio is expansive, however several firms are investing seed capital and early-stage start-up funds for industrial processes, clean technology, and water-based solutions. Through continued investments from the internal VC community, an endogenous paradigm shift in national R&D investment could trigger the Detroit region as a hub for water-related technology innovation.

State of Michigan Venture Capital and Angel Investors: Water-based & Clean-tech Portfolios



Investment Type

- **Clean-Tech/Industrial Angel Investors**
- **Clean-Tech/Industrial VC's**

Source: Michigan Venture Capital Association (MVCA), 2011

Each entity is a crucial actor of the Center's public-private partnership and the subsequent development of Center.

Together, each initiative, from academic research, policy, and the venture capital community in and outside of the State, forms the foundation for an Urban Great Lakes Water Research Center. Each entity, including the Detroit Economic Growth Corporation, with support from the City of Detroit, State, and Federal government can catalyze an Urban Great Lakes Water Research Center by facilitating the necessary partnerships to ameliorate academic parochialism, introduce industry-university collaboration, and commercialize products that preserve and enhance the Great Lakes, while diversifying the City of Detroit's and the region's economy.

Detroit CSA Great Lakes Initiatives, Research Entities,and Governmental Actors

The history of the Great Lakes region is rich and the current mix of initiatives is vast. The range of academic research, government and university sponsored laboratories, non-governmental organizations, innovation centers, and a growing venture capital community allows for the possibility of regional economic diversification. While the majority of the programs are located in Detroit's Combined Statistical Area, they are disjointed, begging the need for a public-private partnership to convene and facilitate the development of a water-innovation center.

An Opportunity Assessment

Water is a necessity of life. Human settlements across the world use it for drinking, sanitation, and cooking. Historically, cities located on rivers, coasts, and lake shores utilized surface water for transportation of goods, recreation, and commercial fishing. Human exploitation can also increase vulnerability to extreme man-made and natural events in freshwater bodies (Hering, 2011). The central importance of water to civilization is evidenced by past and present infrastructure investments in water conveyance, storage, and treatment. Pricing of water is also variable, and therefore, its societal value is often contradictory. Furthermore, the availability and scarcity of clean water sources are primarily local issues, but water-transfers, global water trade, and trans-boundary issues resulting from water bodies that cross political boundaries, requires an international focus. The varied uses of water for drinking, hygiene, industrial processes, and irrigation pose inherent sustainability conflicts in treatment, withdrawal, and the functional preservation of ecosystems (Hering, 2011).

The competing processes of wastewater treatment, society, and eco-systems necessitate a research and technology center.

It is this conflict between industrial waste and sewage discharge, maintenance of healthy fisheries in the Great Lakes and other freshwater bodies, water scarcity, and preservation that demands a council and research center to develop technology, research, educate, and consult governments on how to best manage and provide freshwater nationally and internationally.

A Hub of Water-Based Agglomeration

Cumulatively, the data reveals that if the Detroit MSA continues to rely on a mono-industrial economy it will continue to decline and lose its competitiveness to other regional MSAs. Specifically, the region is losing population, GDP is not growing at an equivalent rate compared to other regions, and the use of STEM graduates outside of the auto-industy is lacking. However, the data also reveal positive trends that indicate the region has the skill-sets, if re-tooled, to create innovative agglomeration economies outside of automotive manufacturing.

State, regional, and local governments might consider focusing policy and invest in STEM graduates, while providing resources to transition engineers into water-based engineering sectors. In addition, governmental actors might consider prioritizing investment that is focused on Great Lakes preservation and aging municipal water infrastructure that could, in turn, facilitate innovation.

A more entrepreneurial governance structure is needed to advance a synergistic

network between industry, institution, and investment (Harvey, 1989). Hence, an entrepreneurial governance structure to overcome the inherent conflicts of sustainable development and the advancement of the Urban Great Lakes Water Research Center can advance a robust water-based network. The success of an entrepreneurial government in fostering an Urban Great Lakes Water Research Center is dependent upon several factors. First, the demand for industrial R&D is a key driver in the innovation process (Feldman & Florida, 1994). Innovation is thus dependent on private industry presence, need, and demand. Second, there must be university R&D related to the industrial demand. Third, business services and private industry investment are also highly correlated to innovation agglomeration. Lastly, the role of academic R&D and its relation to industrial R&D is also a determinant in fostering innovation clusters (Feldman & Florida, 1994). Therefore, the notion of the public-private partnership, in which local boosterism is intertwined with local governmental powers to attract external resources, funding, and investment for the Urban Great Lakes Water Research Center is worth pursuing (Harvey, 1989).

"...the notion of the public-private partnership, in which local boosterism is intertwined with local governmental powers to attract external resources, funding, and investment for the Urban Great Lakes Water Research Center is worth pursuing."

Technological innovation and economic development are linked to the proximity of industrial activity and academic R&D, as well as historic processes. As regions develop certain skill-sets and capabilities, they become fixed to the region. These traditional processes reinforce specialization and innovative capacity. Innovation, therefore, benefits from the clustering of related industries, institutions, and synergistic networks (Feldman & Florida, 1994). This does not mean that Detroit is destined to remain a cluster of automotive innovation, quite the contrary. The engineering skill-set that for so long has facilitated innovation in the automobile industry can be used to foster innovation in water. The region's academic institutions are engaged in innovative water research, including renewable energy, stormwater management practices, utility monitoring, infrastructure upgrades, and preservation.

Together, the region has assets in STEM talent, historical innovation processes, institutional R&D capacity, and the natural resources to enable a water innovation cluster. However, the region's reliance on automobile manufacturing is hindering the region's ability to transition and evolve into a knowledge-based, high-tech economy. Thus, local, state, and federal governments, particularly the DEGC, must take an active role in entrepreneurial governance to facilitate a public-private partnership that taps into the region's existing resources and assets to reclaim and diversify the regions economy into a water-based hub.

Summary of the Region's Scientific Capacity

The region's production, workforce, and educational capacity is sign of great potential for the City of Detroit and the State of Michigan, as a whole. The

inability to harness and retain the educated talent has plagued the region for several decades. Nevertheless, as the region and the country emerge from the Great Recession, unprecedented opportunity is beckoning.

The Detroit MSA among eight Rust Belt contemporaries has the second largest population at 4,292,060. The Detroit MSA also contributes $199,378,000,000 to the nation's GDP, translating into the 14th largest contributor to the nation's GDP and second most within the Great Lakes mega region (Dewar, 2010; US Bureau of Economic Analysis). However, the region's production and population eminence is declining. Between 2001 and 2011, the region lost 4% of its population, while the Philadelphia, Baltimore, and Milwaukee MSAs increased population by 5%, 6%, and 7%, respectively (US Census Bureau). Similarly, the Detroit MSA's GDP growth rate is increasing, but at a much lower rate than its Rust Belt MSA contemporaries. The Detroit MSA experienced a 9% increased in GDP between 2001 and 2011 (US Bureau of Economic Analysis). As compared to the Cleveland and Pittsburgh MSAs, however, the Detroit MSA's GDP increase was 18% and 27% less, respectively (US Bureau of Economic Analysis). This illustrates the precariousness of the region's future. It is also evidence that the region must diversify its economy to curb population loss and increase its dominance as a major contributor to the nation's GDP.

Between the Detroit metropolitan region's higher education capacity, specialization in engineering professions and industry, gorwing VC investment, and existing comprehensive planning and economic development plans, the region and the City are poised for economic diversification.

The region is also a hub for educating talent. The region's educational attainment does not exceed that of the United States overall, but it is on par. The region's population of persons 25 and over with bachelor's degree or higher is just over 25%, where the United States as a whole is approximately 27% (US Census Bureau). More striking, however, is that within the Michigan State, Wayne State University, and University of Michigan institutional cluster, the three universities in 2011 graduated 6,449 STEM students. As compared to institutional clusters in Indiana, Illinois, Wisconsin, and Ohio, the Michigan cluster comprises 28% of total STEM graduates throughout the region. In addition to educating a talented STEM workforce, the region is highly concentrated in Commercial and Industrial Designers and Engineers. The Occupational LQs for a wide-range of engineering professions range between 7.82 and 1.01. Taken together, the educational capacity and resulting occupational clusters facilitate innovative research, design, and technology developments in a variety of markets. The State is also expected to see an increase in STEM-based employment in 2020. As such, there is considerable growth and demand for civil, mechanical, and industrial engineers by the year 2020 (US Bureau of Labor Statistics).

The region's VC Investment is also growing. In 2008, 15 firms involved in industrial processes, bio-medical, high-tech, and clean-tech R&D were located in Michigan. By 2011, 20 firms had located to the region. Furthermore, the rate in which the average capital fund size is growing is quite steady from $38 million in 2008 to $41 million in 2011. In addition, these firms are

clustering in and around the Ann Arbor area (MVCA, 2011). Therefore, it is fair to assume that positive spillovers will occur between the Angel donations, VC investment, university researchers, and the technology transfer offices, fostering continuous deal flow.

Finally, between the Detroit Future City Framework and a saturation of water-based and sustainable research, coupled with educational capacity, a growing STEM employment cluster, and VC investment, the region has unprecedented opportunity to capitalize on its natural resources and existing assets. Establishment of an Urban Great Lakes Water Research Center will economically diversify the region and foster a regional governance structure that enables sustainable water research, innovation, and technology development.

The Need for Water Infrastructure Retrofits, Recovery, and Ecosystem Restoration

Declinign regions are faced with dire constraints in improving and replacing water infrastructure. Therefore, new cost effective and energy efficient technologies are needed to reduce the cost burden associated with treatment and distribution.

The need for new water infrastructure in Detroit and across the nation is a looming national issue. It is estimated that the cost to build and replace water and sewer lines across the United States ranges from $660 billion to $1.1 trillion over the next two decades. In the Great Lakes region alone, the cost for upgraded deteriorated wastewater infrastructure systems upgrades is estimated at $967 million (Burton & Scavia, 2010). The State Revolving Loan Fund, which states use to fund infrastructure investment was allocated $9.5 billion by United States Congress between 1997 and 2008 (Burton & Scavia, 2010). Further exacerbating deterioration, water and wastewater infrastructure is paid through user fess and taxes from businesses and households. Yet, the majority of households pay less than two percent of their household income for water services, representing an investment that is 50 to 100 percent less than any other western industrialized nation. Moreover, regions in most need of infrastructure retrofits are rapidly declining. Cities like Detroit have lost significant tax base to pay for improvements. Therefore, new, cost-effective technologies are needed to repair regional water infrastructure systems.

Too often wastewater treatment processes and sustainability are associated with material and energy consumption, not the effects that it has on the hydrological cycle. By understanding wastewater processes through the lens of the hydrological cycle first, then assessing the impacts on energy and material sustainability, planning and design of technologies can achieve maximal benefits of water quality and availability, while simultaneously addressing energy and material consumption (Guest & Skerlos, et al., 2009). Technological developments, which incorporate water, energy, and resource recovery, while addressing the appropriate stakeholders and designers, can facilitate an agreed-upon sustainability mission and successful implementation for wastewater infrastructure and recovery, thereby reducing the negative

impacts on the water cycle and energy and material consumption.

Our nation's waterways are degraded ecosystems that are a growing challenge. Nowhere is this most more acute than in the Great Lakes. In 2009, four of the ten most contaminated beaches were located within the Great Lakes ecosystem. Further, the Great Lakes are and have been plagued with invasive species, resulting in a dwindling fish stock and over 3,300 days of beach closings in 2009 due to pathogens from combined sewer overflow (CSO) discharge. Climate change is also a growing concern through the reduction of ice cover, and thus lower lake levels. (Burton & Scavia, 2010).

The Economic Benefits of Improvement, Recovery, and Restoration

In addition to the environmental and societal benefits of wastewater, drinking water, and fresh water investment, there are also huge economic opportunities. Water-based research, technology development, education and outreach, and restoration efforts are broad in scope and geography. Specifically targeted to the State of Michigan, there are far-reaching benefits. First, research, technology development, and local strategies for near shore restoration can increase fish spawning and the abundance of Great Lakes fisheries, resulting in economic benefits ranging from $0.5 to $2.4 billion (Vaccaro, et al., 2009). Second, it is estimated that the operating costs 0f lake-associated water treatment plants is as much as $600 million annually. It also thought that a one percent decrease in sedimentation leads to a 0.05 percent decrease in operating costs, translating into a $21 - $25 million annual decrease in water treatment costs throughout Michigan. Third, technologies that improve municipal wastewater facilities, retrofit CSOs, develop natural storm water management systems and reduce non-point communication sources, could lead to a 20% reductions in beach closings (Vacaro, et al., 2009). This translates into additional tourism dollars that provide economic benefits upwards of $2 - $3 billion in tourism (Vaccaro, et al., 2009). Fifth, improved water quality and accessibility can improve quality of life benefits, and potentially raise property values.

"In addition to the environmental and societal benefits of wastewater, drinking water, and fresh water investment, there are also huge economic opportunities."

Research & Knowledge Transfer Foci of the Urban Great Lakes Water Research Center

Based on the educational capacity, institutional recognition, employment specialization, and the regional, national, and international water infrastructure needs, the Urban Great Lakes Research Water Center might consider having a broad focus that is tailored specifically to the region's assets, infrastructure exigencies, and natural resources. The research foci and technology development activities encompass each tenant of sustainable development.

Activities should focus on urban water management, valuating climate change adaptation technologies, cost-benefit analysis of decentralized and centralized wastewater technologies, green infrastructure design and monitoring, process engineering, and environmental-related social sciences.

Sustainable Urban Water Management

As a result of deferred infrastructure maintenace, climate change, rapid global urbanization, and declining post-industrial cities, there are numerous research foci for an Urban Great Lakes Research Water Center.

Sustainable Urban Water Management (SUWM) is a global effort, prevalent in countries facing extreme droughts and poor water quality. SUWM refers to the practice of managing freshwater, wastewater, and stormwater as an integrated resource management strategy, using a regional urban area as the unit of management. Activities are extensive and include: (1) improvements of water supply efficiency; (2) provision of adequate water quality for drinking water; (3) improvement of economic efficiency to reduce operating costs of water treatment; (4) utilization and recovery of alternative water sources; (5) strategies that stress community input, and; (6) the promotion of a regional governance reform to enable a structure to coordinate and implement SUWM.

Within the context of the Detroit region, SUWM provides several advantages. First, the SUWM is regional in nature and could advances efforts for a regional governance structure. Second, there is a need for a Center where research is conducted to quantify the characteristics of existing Great Lakes urban water infrastructures. Third, research is needed on the technical feasibility and economic evaluation of new technologies for decentralized alternative sewer systems. The economic rationale, coupled with on site treatment technology development and alternative gray water collection systems, reduces, shifts, and uncovers the investment risk for both the public and private sector, thus enabling commercialization and product marketability.

Valuation of Climate Change Adaptation and Technologies

The impacts of climate change in the Great Lakes region are and will continue to be severe. Precipitation in the Midwest is likely to occur more frequently as heavy downpours, increasing the likelihood of flooding and disruption in services (EPA, 2012). More frequent heavy downpours will strain wastewater systems unless they are rebuilt or alternative systems are developed and implemented. If nothing is done, CSOs will experience increasing rates of over capacity and discharge into freshwater bodies. The need to develop adaptive technologies to mitigate the expected poor water quality and additional burden on wastewater systems is clear. Again, the valuation, cost-benefit analyses, and monitoring of emerging technologies and alternative systems that deal with wastewater outfalls are crucial to the R&D continuum and to sustaining adequate water quality.

Wastewater Process Engineering

Wastewater process engineering is a broad research and technology focus. Yet, for the Urban Great Lakes Water Research Center technology transfer will focus on the current and future treatment of drinking water and wastewater and resource reuse. This focus will work closely with the Urban Water Management group to develop sustainable concepts for water and nutrient cycling for urban areas. In addition, researchers should work closely with national professionals, municipal treatments plants, and federal environmental agencies to facilitate technology transfer and implementation. Specifically, research and development will focus on sludge treatment, re-use of water waste, and technology to convert waste into electricity, decentralization products and systems to re-use gray water, and heat recovery methods to partially power wastewater treatment processes (Eawag website, retrieved April, 2013).

Environmental Social Sciences Implications

While it is necessary to have extensive research and technology development capacity, the need for policy formulation, innovative governance structures, and community participation is crucial for water-based innovation. The research would garner national attention on the increasing national and international societal problems associated with water. Specifically, it would research, analyze, and work closely with governmental actors to reform institutions that regulate, permit, and address environmental problems. In doing so, the research and engagement will contribute to a better understanding of urban water management, ecosystem services, sustainability-related reforms to urban and state water management sectors, and new policy to facilitate technology demonstrations (Eawag website, retrieved April, 2013).

"The primary mission of the Urban Great Lakes Water Research Center is not only to conduct research and engage policymakers on sustainable water innovations, but to commercialize clean-water technology through industry agglomeration."

Knowledge and Tech Transfer

The primary mission of the Urban Great Lakes Water Research Center is not only to conduct research and engage policymakers on sustainable water innovations, but to commercialize clean-water technology through industry agglomeration. In the Detroit region this is achievable with when several characteristics and linkages are present. The cluster's ability to promote and impact economic development is the presence of university research, the creation of new knowledge, and the diffusion of technology (Lendel, 2010). Therefore, university research and private industry need a physical space where specific services are provided for collaboration and synergy. The incubation of new technologies for early-stage start-ups and acceleration of patented technologies must have certain products and services in place. Such universities

products and services include technology transfer faculty consultants, the brand and image of the university(ies), equipment, existing related R&D activity, labs/workshops, and student employees (Mian, 1995). Correspondingly, the Universities might consider having national and international research recognition to successfully brand and foster agglomeration and positive spillovers (Lendel, 2010). The Detroit region is poised to provide such services and create the branding due to the prestige and resources at the University of Michigan and Wayne State University.

In sum, the Detroit region is not only in need of economic diversification, but also is ripe for water innovation. The education and employment of STEM specialization, the abundance of freshwater, and the region's aging water infrastructure enable the development of an Urban Great Lakes Water Research Center that is broad in research and technology transfer scope. However, current and future problems associated with water quality, supply and distribution, ecosystem preservation, climate change, and aging infrastructure define the scope of water-based technology transfer. As such, the public-private partnership must focus its efforts on creating a facility centered around SUWM, valuation of climate change adaptation technology, wastewater engineering processes, and environmentally-focused social science research to enable the transfer of knowledge and technology for commercialization.

The Feasibility Analysis

While the opportunity for an Urban Great Lakes Water Research Center in Detroit is eminent, the feasibility of a public-private partnership is tenuous. Although models of agglomeration economies, the prevalence of incubators and open-innovation in corporate R&D, and the role of federal and state governments signal potential for an Urban Great Lakes Water Research Center public-private partnership. This chapter is presented in several sections. The first will highlight how firm clustering, open innovation, and agglomeration economies can have positive spillover effects for R&D sectors. The second will suggest the role federal and state governments can play in facilitating an innovation-based public-private partnership; specifically, the Urban Great Lakes Water Research Center. The third will formulate of the partnership and the role the Detroit Economic Growth Corporation might play in convening stakeholders. And the fourth details the limits and constraints the DEGC could face in developing a public-private partnership of the Urban Great Lakes Water Research Center.

Cluster Firm Performance: Water Agglomeration in Detroit

"The "Big Three's" tight control of Detroit's area resources in the past and present continues to prevent the diversification of its economy during the massive globalization of the automobile industry."

An oversimplified historical perspective of Detroit's fate is tied to its over dependence on the of the auto industry agglomeration (Chinitz, 1960). The "Big Three's" tight control of Detroit's area resources in the past and present continues to prevent the diversification of its economy throughout the globalization of the automobile industry. As a counter to Detroit's dependence on an oligopolistic industry, Seattle and Boeing's relationship provides a lesson in the positive aspects of spillover industrial economies. Boeing served as the anchor industry throughout Seattle's development. Unlike Detroit, however, Boeing, as the lead firm, contributed to the region's diversification in sectors such as, port-related activities, software, and biotechnology, positioning it well to withstand the globalization of the aircraft industry (Markusen, 1996). It behooves the City of Detroit and the region to learn from its mistakes of mono-industrial dependency and focus on clustering smaller firms supported by institutional anchors.

Clusters are geographic concentrations of interconnecting firms and institutions within a specific field and/or sector. Clustering allows firms to operate more productively in sourcing inputs and talent, accessing complementaries, partnering with institutions, and coordinating with related companies (Porter, 1998). Companies involved in active clusters can access a pool of specialized and expert employees, as well as suppliers, thereby lowering transaction costs

in recruitment and supply chain. Specialized knowledge also develops in cluster formation, enabling companies' access to markets and technical information through networking and shared inputs. Further, the role of public and university institutions can enhance the competitiveness of firms in a cluster. Firms have the ability to recruit employees trained at local programs, secure funding for technology and infrastructure upgrades, and rely on a reputation that arises as by-product of institutional support. Lastly, clusters allow for complementaries. Related firms intentionally or unintentionally collaborate due to their mutual dependency (Porter, 1998). This collaboration leads to complementaries that support lower cost inputs and additional business activity.

Taken together, regional agglomeration economies and firm concentration have several policy implications. Specific to the Urban Great Lakes Water Research Center, a narrow regional specialization (i.e. automobile industry) with unrelated economic activities, bears the consequence of diminishing returns and hinders positive spillovers and externalities. However, the presence of complimentary activity with broad regional specialization is a strong factor, allowing firms ready access to key inputs, strong interactions with customers, and innovation (Delgado, Porter, and Stern, 2011). Therefore, the development of a water-innovation cluster will have a broad R&D focus, utilizing shared complimentary inputs, and thereby achieving employment growth and higher wages for the region.

The key to the success of the Urban Great Lakes Water Research Center is a "State-Anchored District" industrial formulation.

In pursuing a water industry cluster through the auspices of an Urban Great Lakes Water Research Center, the "State-anchored District" model of industry formulation is required. Examples of these districts are found in cities like Colorado Springs, Ann Arbor, or Madison, where the performance and presence of military bases, research labs, state governments, or top-ranked universities are the driver for economic growth and development. Such actors act as public-sector entities that dictate formulation or cluster (Markusen, 1996). In general, scale economies and "patient capital" are not required because the state-owned facilities are so large and firms are dependent on public expenditure for suppliers, inputs, and complimentary business activity (Markusen, 1996). Similarly, the long-term success of "State-anchored" industrial districts is dependent upon the degree to which public expenditure encourages growth locally and regionally. The spawning of local suppliers, new business spin-offs, and the creation and supply of labor to the local economy is the objective of "State-anchored" expenditures (Markusen, 1996).

In the case of the Urban Great Lakes Water Research Center, the public-private partnership serves as the advisory state-anchor entity. The DEGC's role is to convene the necessary stakeholders, including federal and state government, private investors, university researchers and labs, NGOs, and incubators to create the anchor entity. The Urban Great Lakes Water Research

Center would support the development of the water cluster by funneling resources from various entities to channel innovation and growth in a broad spectrum of water-industry. The synergistic nature of the Center would enable complementaries and share inputs from labor to suppliers and knowledge to commercialization, engendering a water-based innovation cluster in Detroit.

"The Urban Great Lakes Water Research Center would support the development of the water cluster by funneling resources from various entities to channel innovation and growth in a broad spectrum of water-industry."

The Role of Higher-Level Government in Innovation

The need for federal and state intervention in the creation of an Urban Great Lakes Research Center is acute. Without federal support, the feasibility of the Center's public-private partnership and subsequent implementation is unlikely. The cornerstones of the Urban Great Lakes Water Research Center are to: (1) facilitate market development through brand building; (2) encourage relationship building within the cluster; (3) promote collaborative innovation in research, product and process development, and commercialization; (4) support cluster expansion through business development (Mills, Reynolds, and Reamer, 2008). Pursuant to these goals, the federal and state government can play a crucial role in supporting the Urban Great Lakes Water Research Center and aiding in industry concentration.

Generally, clusters are industry-led with support from federal and state governments. At the outset of the public-private partnership, the DEGC has a crucial role to play. From a public policy perspective, if the private sector and various research institutions have not arisen or begun communication, the DEGC might consider an intensive identification process and start convening cluster participants and stakeholders (Porter, 2011). In doing so, the DEGC can garner support and resources from higher levels of government to facilitate the development of the Urban Great Lakes Water Research Center and the subsequent water cluster.

Utilizing bottom-up federalism is the key to cluster formation and is the appropriate use of federal resources.

Once the stakeholder engagement process commences, the federal and state governments must actively engage. Currently, federal and state governments are pursuing a more bottom-up approach in advancing national innovation policy (Katz & Muro, 2012). In keeping with "bottom-up federalism," the DEGC must engage federal and state governments for technical resources and financial support. Increasingly, state governments are providing matching grants and incentives to the private sector to stimulate and encourage R&D investment. Accordingly, the DEGC must lobby for funds specific to the development of the Urban Great Lakes Water Research Center and the convening of the stakeholders.

However, monetary inputs from the state are not enough. The utilization of national programs targeted towards clustering are necessary to facilitate a public-private partnership. National programs have the ability to provide information, knowledge, and financial resources that cross jurisdictional

boundaries, allowing for regional cluster development (Katz & Muro, 2012). The DEGC should identify national resources that:

- Provide information on cluster compositions, performance, competitive structures, and trends. The DEGC can use such information to chart collaborative strategies for the development of a competitive water-based cluster;

- provide funding to support the Urban Great Lakes Water Research Center through the creation of large peer-to-peer networks and cluster indicator performance measures;

- provide funding for technical assistance to develop and implement the stakeholder engagement process, and;

- encourage the DEGC to take advantage of existing cluster initiatives, including, economic and workforce development programs, infrastructure grants, and R&D assistance (Mills, Reynolds, and Reamer, 2008).

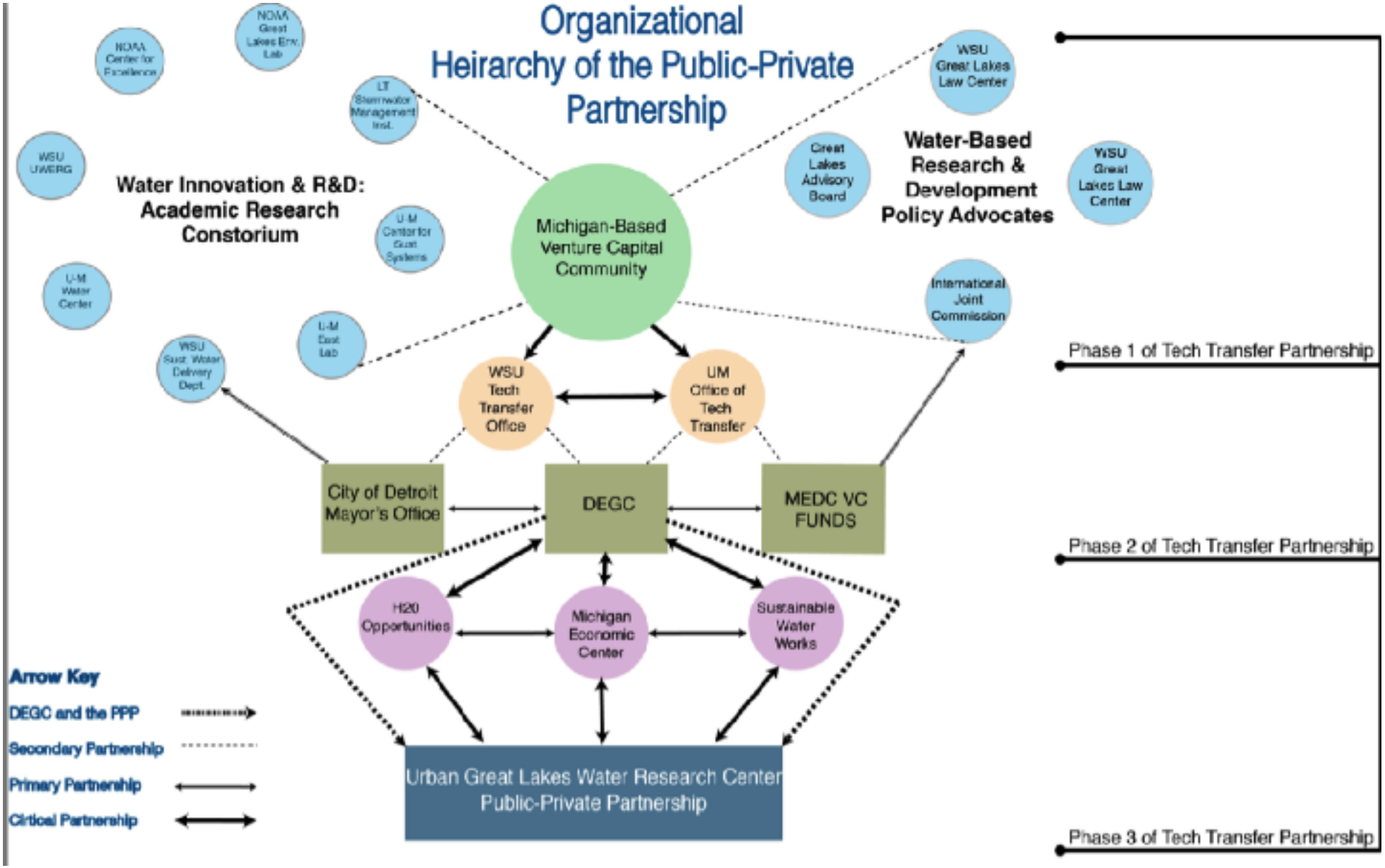
By utlizing resources provided by the federal government, the DEGC can develop detailed information on water-based cluster performance, and provide funding and technical assistance for the Center's development

The DEGC's ability to utilize the resources provided by the federal government is critical. Yet, there are limitations to tapping into federal resources. The federal government is not structured for seamless assistance to lower level governments. The federal government is comprised of an abundance of agencies working in silos. Generally, these agencies pursue overlapping objectives without ever knowing (Katz & Muro, 2012). Therefore, much of the funding and technical assistance provided by the Fed's is duplicative and too broad to effectively assist in regional cluster development.

Nevertheless, the DEGC might consider engaging both state and federal governments at the outset of the Urban Great Lakes Water Research Center stakeholder development. By doing so, it will enable a more informed process through technical assistance and sustainable financial mechanisms, ensuring a greater chance for success.

The Proposed Urban Great Lakes Water Research Center Public-private Partnership

The proposed public-private partnership for the Urban Great Lakes Water Research Center consists of a three-phased approach. The DEGC, in conjunction with the City of Detroit, and the Michigan Economic Development Corporation (MEDC), are the central link throughout the convening process. The first phase of the public-private partnership is the engagement of the University of Michigan, Wayne State University, and Lawrence Tech. This convening process will lead to the academic research partnership that


Organizational Heirarchy of the Public-Private Partnership
NOAA Great Lakes Env. Lab
NOAA Center for Excellence
LT Stormwater Management Inst.
WSU Great Lakes Law Center
WSU UWERG
Water Innovation & R&D: Academic Research Constorium
Great Lakes Advisory Board
Water-Based Research & Development Policy Advocates
WSU Great Lakes Law Center
U-M Center for Great Systems
Michigan-Based Venture Capital Community
U-M Water Center
International Joint Commission
U-M East Lab
WSU East Water Delivery Dept.
WSU Tech Transfer Office
UM Office of Tech Transfer
Phase 1 of Tech Transfer Partnership
City of Detroit Mayor's Office
DEGC
MEDC VC FUNDS
Phase 2 of Tech Transfer Partnership
H20 Opportunities
Michigan Economic Center
Sustainable Water Works
Arrow Key
DEGC and the PPP
Secondary Partnership
Primary Partnership
Cirtical Partnership
Urban Great Lakes Water Research Center Public-Private Partnership
Phase 3 of Tech Transfer Partnership

fosters a high degree of collaborative research surrounding freshwater, urban water processes, desalination, limnology, etc. Simultaneously, the DEGC, the City, and the MEDC will engage policy-based organizations involved in Great Lakes restoration and preservation. Concurrent convening will mitigate the traditional parochialism of academic research, while eliminating the red tape and cumbersome process of granting pilot project demonstration. In addition to Phase 1 of stakeholder engagement, it is assumed that academic researchers already have a network of VCs that are brought to the table throughout the R&D continuum. Therefore, developing networks for R&D is not a necessary or pertinent element for Phase 1 of the partnership

Phase 2 of the public-private partnership engagement is with respective university technology transfer offices and the VC and angel donation community. Again, the DEGC serves as the primary facilitator between the University of Michigan and Wayne State University's tech transfer offices. The purposed Phase 2 is a matching process, whereby the investment community and each respective office identify parallel research themes. This allows for greater synergy between the researchers and laboratories, as well as with potential investment dollars. Second, the MEDC and the DEGC will determine the extent of additional resources needed to facilitate continuous deal flow and a high degree of technology transfer.

"Taken together, the three-phase proposed partnership structure is an amalgam of academic research, policy advocates, VC investors, institutional technology transfer offices, and specialized R&D mentoring organizations, acting as a cohesive unit enabled by the public-sector to create a physical R&D space."

Finally, Phase 3 is the partnership with organizations that specialize in mentorship and securing resources for early stage start-ups. These organizations are intended to garner "patient capital," provide resources, and guide start-up's throughout all phases of the commercialization process. They are also the necessary element to help start-ups identify funding streams throughout each stage of the start-ups R&D process, introduce the start-ups to suppliers and labor inputs, as well as expand networks outside of the region.

Taken together, the three-phase proposed partnership structure is an amalgam of academic research, policy advocates, VC investors, institutional technology transfer offices, and specialized R&D mentoring organizations, acting as a cohesive unit enabled by the public-sector to create a physical R&D space. Each phase and entity provides a critical element in the innovation life-cycle, as to diversify the region's economy, increase employment and educational opportunities, and brand the Detroit region as a global, sustainable water innovation hub.

The Specific Role of Each Stakeholder Group

Technology innovation is a cumbersome process, involving several stages, actors, and institutions. Conventionally, the stages of innovation fall into four categories: first, the R&D stage; second, Stage 1 where governmental approvals are needed; third, Stage 2, where market forces and business

strategy is developed; and, Stage 3 & 4 where the product or process is commercialized and sold on the market. This process is never seamless and requires various resources and inputs. The table below describes the issues that arise, the resources that are needed, and the expertise to take an early stage idea into commercialization. Furthermore, the table serves a useful guide to highlight the individual roles each stakeholder involved in the Urban Great Lakes Water Research Center public-private partnership.

Life Stage	R&D Stage	Stage 1	Stage 2	Stage 3 & 4
Issues	• Access to seed capital • Research partners • Cutting-edge technology • Concepts to marketable products	• Secure patents • Gain governmental approval • Brand and build market awareness of product type	• Market due dilligence • Leverage technology to enhance production and competitiveness • Continue to build strong brand image for supply contracts • Seek buy out	• Competition • Market saturation • Economies of scale • Need to develop next generation of technology
Capital Needs	• Seed capital & angel investment	• Venture capital	• Investment capital to expand	• Working capital
Talent Needs	• Researchers and entrepreneurs	• Enrepreneurs	• Market researchers	• Minimizing labor cost
Real Estate	• Lab, office, pilot space, and synergistic environment	• Below-market lab, office, and production space	• Space to keep pace with growth and market access	• Consolidate assets and overhead costs
Leadership	• Innovative and persistent	• Ability to multi-task	• Ability to create network and expand responsibilities	• Multi-skilled

For the early stage entrepreneur, capital needs throughout the entire R&D process are critical. As such, several of the stakeholders represented in the proposed partnership model are crucial for the provision of capital to incubate and accelerate water-based technology. The link between the regional venture capital community and research is crucial. While the role of the researcher

in facilitating the relationship with the VC community is a necessary first link, the relationship that the university technology transfer office has with the investment community can facilitate long-term and continuous funding. During the R&D stage, seed, early stage, or angel capital is needed to develop the cutting-edge technology. In Stage 1, venture capital is needed for the granting of governmental approvals, securing of patents, and building the market through branding. Also, equally important in Stage 2, are the freshwater policy advocates that will aid in the approval processes and granting of permits to conduct demonstration projects, and assess the viability of the product or process. Similarly, during Stage 2 outside investment capital is required to build an even stronger brand, conduct market due diligence, and leverage other technology in hopes of attracting a buy-out. In the event that the product is bought out and commercialized, economies of scale in production is the next step. To minimize costs during production, working capital is necessary to expand production and capacity. Therefore, the connection between the investment community, researcher, technology transfer offices, and policy advocates allows capital to flow and potentially mitigate unforeseen issues during the investment phases of innovation cycle.

The role of each stakeholder during the innovation lifecycle process is critical to the success of fostering commercialization and the Urban Great Lakes Water Research Center.

In addition to capital resources, the innovation cycle requires talent. Throughout all phases researchers, students, market experts, labor, and entrepreneurs are necessary actors. Specific to the Urban Great Lakes Water Research Center, the various institutes, labs, and academic programs at Wayne State University and the University of Michigan are the main suppliers of talent in the region. However, without direct coordination between academic institutions and public entities, the placement of talent and knowledge from these institutions to a regional consortium will be lost. The Detroit Economic Growth Corporation and the City of Detroit's Mayor's Office, along with the Michigan Economic Development Corporation play a pivotal role in providing incentives that not only transfer research into a physical space in Detroit, but to also provide workforce development for laborers that will manufacture the products and processes.

The ultimate benefit of the Urban Great Lakes Water Research Center is economic diversification and product development in a single physical space. Hence, the need for real estate and cutting-edge facilitates to support R&D. Throughout all stages of innovation lab, office, and pilot space can provide a collaborative environment. However, for many early stage entrepreneurs and researchers, the need for below-market rents is critical. Therefore, the Urban Great Lakes Water Research Center partnership between the City of Detroit and the DEGC, with state and federal incentives are critical for the development and subsidization of a physical space. The City could provide the space; the DEGC might construct physical improvements, provide incentives, and matching grants, as well as lobby for other funding sources from state and federal governments. Effectively, the DEGC is the necessary arm for the provision of real estate and the redevelopment of an underutilized industrial

building into an Urban Great Lakes Water Research Center.

The Potential Constraints

While the Detroit region has the potential to catalyze an Urban Great Lakes Water Research Center and public-private partnership, still many barriers exist for a successful development and implementation. The pervasive constraints that must be considered at the outset of the public-private partnership is the lack of industry demand throughout the region, Detroit and Michigan's continued outmigration of talent, and the increase of Venture Capital is not sufficient enough to sustain continuous lead funding.

As a result of the mono-industrial nature of the auto-industry, the presence of water-based industry is not present in the region. It is commonplace in research and development activities that the commercialization of research is dependent on the regional industry's needs (Bieri, 2013). This notion poses serious constraints for the success of an Urban Great Lakes Water Research Center in achieving high returns on investment. Nevertheless, the region is located on a major shipping route, which provides opportunity for importation and exportation to global markets that are demanding water products and processes. In addition, the abundance of freshwater and the State's dependence on it for tourism, commercial fishing, and drinking water presents itself as an ancillary industry that the Urban Great Lakes Water Research Center can take advantage of.

The region and the state face pressing obstacles in achieving high returns from investment in water-based technology and. The DEGC and the public-private partnership will have to face the lack of industry demand and poor college graduate retention rates.

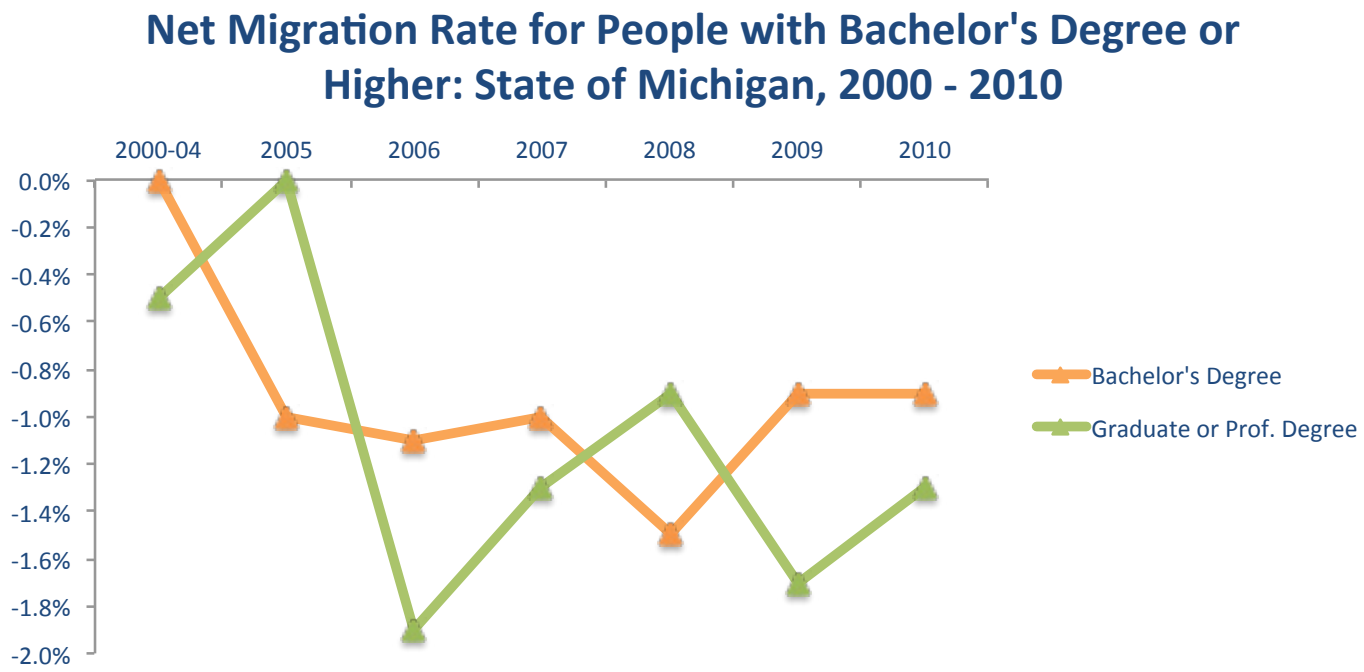
State of Michigan National Retention Ranking (2007 - 2010)

Education Attainment	2007	2008	2009	2010
Some College	39	42	47	48
Bachelor Degree	47	48	45	48
Graduate or Prof. Degree	48	46	48	45
Bachelor's Plus	47	46	48	47

Source: State of Michigan Department of Budget & Technology
Note: 1 = Highest (best) in nation; 51 = lowest (worst) in nation

In addition to the lack of industry demand and support, the region and the state is confounded with out-migration of young talent. The State of Michigan consistently ranks as one of the highest states for poor retention. Between 2007 and 2010, the State ranked between 46 and 48 out the 50 states in retaining residents with a Bachelor's degree or higher. Moreover, The net migration of residents from the State of Michigan to another state with a bachelor's degree between 2000 and 2010 is increasing steadily (State of Michigan, 2010). Between 2000 and 2004, the net migration for persons with either a Bachelor's or Graduate degree was 0.0%. By 2010, the net

migration for persons with a Bachelor degree hovered around -1.0% and -1.4% for persons with a Graduate degree (State of Michigan, 2010). If this trend continues to increase, the likelihood of the Center coming to fruition is poor. However, the Center presents opportunity for STEM-based graduates to stay in the region and engage in meaningful and profitable research, and could help to curb this trend.



Source: Author's Calcuations &US Census Bureau American Community Fact Finder

Even with the recent spur in VC investment throughout the region and state, the increase in investment pales in comparison to established regions across the country. Total VC investment was $232 million in FY 2012, a huge increase from $85 million in FY 2011 (PriceWaterHouseCoopers, 2012). However, when compared to states like California, Massachusetts, and even Illinois the State does note compete. California's total VC investment in 2012 was approximately $14 billion, a slight decline from 2011 (PriceWaterHouseCoopers, 2012). At the same time, Massachusetts also experienced a slight decline in VC investment from $3.1 billion to $3 billion (PriceWaterHouseCoopers, 2012). Furthermore, the entire Great Lakes region does compare to the VC branded states of California and Massachusetts, with total $12.4 billion in total venture capital invested in FY 2012 (PriceWaterHouseCoopers, 2012). Nonetheless, the minimal amount of VC invested in Michigan poses serious constraints for branding and continuous deal flow to enable R&D and commercialization.

Total Venture Capital by State 2007 to 2012 (in millions)								
Year	Michigan	Ohio	Illinois	Indiana	Wisconsin	Great Lake States	California	Mass.
FY 2007	$109.00	$227.00	$508.00	$71.00	$90.00	$1,005.00	$15,394.00	$3,757.00
FY 2008	$204.00	$275.00	$502.00	$94.00	$71.00	$1,146.00	$14,770.00	$3,401.00
FY 2009	$179.00	$123.00	$258.00	$232.00	$26.00	$818.00	$10,258.00	$2,382.00
FY 2010	$151.00	$177.00	$658.00	$79.00	$135.00	$1,200.00	$11,919.00	$2,449.00
FY 2011	$85.00	$432.00	$771.00	$179.00	$73.00	$1,540.00	$14,723.00	$3,132.00
FY 2012	$232.00	$289.00	$540.00	$84.00	$95.00	$12,400.00	$14,089.00	$3,034.00
TOTAL	**$492.00**	**$625.00**	**$1,268.00**	**$397.00**	**$187.00**	**$2,969.00**	**$40,422.00**	**$9,540.00**

Source: MoneyTree Report, 2012

Sustainable development and even more elusive sustainability are frequently referenced as the underlying objectives in architecture, urban planning, public health, and environmental science realms; yet sustainability is equivocal. Essentially, to achieve sustainable development, "the planner must reconcile not two, but at least three conflicting interests: to expand the economy, distribute the growth fairly, and in the process not degrade the ecosystem (Campbell, 1996)." The "Planner's Triangle" explains sustainable development goals, while emphasizing conflicts that arise in pursuit of sustainability (Campbell, 1996).

"The question remains of how any type of development and planning initiative can reconcile the three tools of the "Planner's Triangle" and equally prioritize to achieve sustainable development."

As a result, the sustainable development professional serves in different capacities. An economic developer may view the city as a market place, aggrandizing the jurisdiction's ability to compete for production, consumption, and innovation (Campbell, 1996). The environmentalist, however, views the city from a resource consumption perspective, where competition poses a threat to natural resources (Campbell, 1996). In contrast, the social advocate views the city as a space for equal distribution of resources and opportunities. Frequently, each interest creates opposition and puts at risk simultaneous achievement of expansion, distribution, and ecological preservation.

In his seminal article, Campbell identified the inherent conflicts of sustainable development and foresaw the prevailing trend of diverging interests. The first conflict rests between economic growth and equity, known as the growth-equity conflict (Campbell, 1996). This conflict arises from a particular good as a private commodity, countered by the need for government intervention to ensure adequacy of that good. The second conflict arises between economic growth and environmental protection, known as the "resource conflict (Campbell, 1996)." This conflict tends to deal with business interests resisting natural resource regulation, while at the same time needing consistent conservation regulation to sustain. Finally, the conflict between environmental protection and social justice, known as the "development conflict (Campbell, 1996)." Fundamentally, the challenge resides in protecting the environment and simultaneously increasing social welfare. As Campbell points out: "How

could those at the bottom of society find greater economic opportunity if environmental protection mandates diminished economic growth (Campbell, 1996)?" The question remains how any type of development and planning initiative can reconcile the three tools of the "Planner's Triangle" and equally prioritize each tenet to achieve sustainable development. As such, these conflicts must be dealt with at the outset of the public-private partnership development, or else equal prioritization of each tenet cannot be achieved.

In sum, the applicable entities needed to form a public-private partnership are present throughout the region. The regional institutions, in the University of Michigan, Wayne State University, and Lawrence Tech provide the region with water-based and freshwater research institutes, labs, programs, and advocacy that enables a high degree of research, educational capacity, and talent generation. Outside of the academic institutions, local, state, and federal organization are located within the region that can lobby for demonstration projects, legislation to facilitate innovation and freshwater policy to engender technological development. Further, the region is comprised of several critical actors that could bolster and mentor early stage start-ups throughout the innovation cycle and R&D process. Despite the multitude of appropriate organizations and institutes, to date, however, the linking of these partnerships has not been aggressively pursued. In trying to create a public-private

partnership extensive stakeholder engagement is necessary. A short-term mindset for investment returns for the both the public and private will only lead to failure. Therefore, a long-term strategy and mentality is needed for the success of the public-private partnership and Center (Lerner, 2009).

Notwithstanding, the region is faced with serious constraints in developing the public-private partnership. The Center is predicated on open innovation and collaboration, while historical R&D processes throughout the metro-Detroit region is generally characterized as closed, pursued by in-house company labs. As a result, the region is dominated by non-collaborative single industry, when the success of a water-based technology agglomeration depends on industry demand, spillover effects, and collaboration between firms. Moreover, the region's ability to attract and retain talent is poor. More and more talented STEM graduates continue to leave the state for areas with plentiful opportunities for meaningful employment. Lastly, branding the area is a venture capital hub in water and industrial processes will be difficult. The metro-region's investment is growing, however, compared to other regions, Michigan's investment dollars are minimal. Furthermore, attempting to equally prioritze the tenets of sustainable development presents a serious obstacle in the long-term success of the public-private partnership. Each entity within the partnership must be heard and their needs addressed, otherwise, the Center will fail in achieving sustianable development.

Appendix A

Detroit Future City: A Blueprint for Innovation

The Impetus for the Detroit Future City Plan

"Detroit was considered the epitome of the American industrial city, the "Arsenal of Democracy," and even the Silicon Valley of the early 20th century...."

At the turn of the 20th century, the City of Detroit experienced unprecedented economic growth and an influx of population. The automobile, the standardization of the assembly line, the five-dollar workday, and the City's locational advantages, enabled the creation of America's middle class. Detroit was considered the epitome of the American industrial city, the "Arsenal of Democracy," and, even the Silicon Valley of the early 20th century (Sugure, 1998). The City and the auto manufacturers were able to meld human capital and technology that together embodied the United States as the pre-eminent industrial capitalist society (Sugrue, 1998). However, this tells only one small part of the City's industrial prominence. By 1920, over 40 percent of the city's industrial employment was in non-automotive sectors, including historical enterprises such as brewing, stove-making, and salt mining (Sugrue, 1998). This historical agglomeration of industries and human capital facilitated a diversified economy, not solely reliant on one industry. In the words of historian Oliver Zunz, Detroit was a "total industrial landscape," unlike the City's current state, as a mono-industrial city, struggling to diversify into the knowledge-based and service sector economy.

The advent of the automobile, unprecedented development of single-family detached housing construction, and a living wage for all skill-sets and races not only spurred unequivocal growth for Detroit, but it also led to its current crisis. In the 1950's, the City's population peaked with over 1.8 million residents. Over the course of 60 years the current population has fallen to just over 700,000 inhabitants (SEMCOG, 2013; American Community Fact Finder, U.S. Census Bureau, 2010). Further exacerbated by racial and labor tension, the passing of the Federal Highway Act and the construction of the interstate freeway system, urban renewal policies that displaced thousands of minorities, industrial mobility, and de facto racist housing policies, the current state of Detroit is dire, and the City is facing an unprecedented fiscal and social crisis (Sugrue, 2005).

"The Detroit Future City Framework outlines the vision, strategies, and goals to improve quality of life for the indigenous population..."

In an attempt to ameliorate and stabilize the economic base and continuing population loss, the civic, business, and philanthropic community initiated a 3-year comprehensive planning process in 2010 known as the Detroit Works

The plan presents an undeniable opportunity for an Urban Great Lakes Research Center to facilitate land use innovation and new forms of employment opportunities.

Project. The project harnessed national and international experts in urban redevelopment to engage community members, craft strategies, and produce a shared vision and framework to guide the future of Detroit's economy, land use, and public service delivery systems (Detroit Future City, 2013).

Known as the Detroit Future City Framework, it outlines the vision, strategies, and goals to improve quality of life for the indigenous population, reduce escalating costs of public service delivery, and provides strategies to both grow and attract new business to the City of Detroit (Detroit Future City, 2013). As such, the 3-year process is founded upon into a set of values, guiding the framework. Such values include health and safety, population, employment, land use, and public service delivery. Accordingly, each value-set informs the framework's five main goals: (1) a stabilized population; (2) increased employment opportunities; (3) a city for all; (4) innovative landscapes; (5) and natural infrastructure systems. While each goal is emphasized equally, a vision of a new landscape typologies that reduces city expenditures, along with generating innovative employment opportunities, are pervasive themes throughout the Framework.

Without directly saying so the framework provides justification for an alluring opportunity for the development of an Urban Great Lakes Water Research Center. Indirectly, the Center contributes to a stabilized population, fostering employment opportunities for Science, Technology, Engineering, and Math professionals, to the innovation of appropriate land uses and technologies, and outreach and engagement for a more inclusive Detroit. Therefore, the issues and challenges that beset the City of Detroit can be addressed through the development of the Urban Great Lakes Water Research Center.

In summary, the five main areas of the Framework are Health and Safety, Employment, Population, Land Use, and City Services

Health & Safety	Employment	Population	Land Use	City Services
A City for All	**Increase Opportunity**	**Stabilize**	**Innovation**	**Infrastructure**
Enhanced, varied, and strong neighborhoods Increased family wealth and affordable housing opportunities Opportunities for higher density living	By 2030, 50 jobs for every 100 residents Seven, specialized job districts Linking skill-sets to the specialized districts	By 2030, a stabilized population of 600,000 to 800,000 Remain one of America's top 20 largest cities Residents will be diverse	Transform vacant land into assets Remediate contaminated land Manage stormwater Create passive recreational amenities	Creation of Blue Infrastructure Creation of Green Infrastructure By 2030, a multi-faceted open space system, providing a strong identity for Detroit in the 21st Century

Source: Adapted from the Detroit Future City Framework

Increased Employment Opportunities

Increased employment pervades the entire Framework and should guide the economic diversification and vitality of the City.

A pervasive initiative of the Detroit Future City Framework is increased employment opportunities. Unlike other major cities with a robust and diversified economy, the City of Detroit must be cognizant of equitable distribution and inclusiveness in workforce development, economic development, and job growth. In the City, there is a dearth of opportunity, requiring city, business, and civic leaders to develop and implement job creation strategies for a multitude of education levels and skill-sets (Detroit Future City, 2013). According to the Framework, employment activity nodes and strategies to facilitate job growth fall under four pillars: (1) education and employment; (2) digital and creative jobs; (3) industrial employment; (4) local entrepreneurship, each with their own strategic agglomeration zone located throughout the City (Detroit Future City, 2013). The Framework also identifies seven core employment districts best suited for each individual cluster. The districts were identified through a specific methodology of matching industry needs with existing infrastructure and locational advantages (Detroit Future City, 2013). These clusters include industrial, industrial and creative (maker spaces), industrial and local entrepreneurship, digital and creative, and educational, medical, and creative.

In addition to the over-arching employment clusters, the Framework also identifies employment clusters to facilitate agglomeration economies throughout the City.

The goals for each district are inclusiveness and the promotion of local, minority-owned businesses are a provocative and over-arching objective for individual cluster. The Framework outlines a fairly broad strategy for the clustering districts, which include a higher degree of public and private collaboration and coordination (Detroit Future City, 2013). For example, the public sector could leverage private-industry investments to create Business Improvement Districts, using each financing tool to become a national leader in green industrial districts, while expanding networks and educational opportunities for minority owned business owners. These green industrial districts present an opportunity to explore and experiment with various infrastructures that requires an Urban Great Lakes Water Research Center. Researchers, designers, and scientists could collaborate to design and monitor green and blue infrastructure, as well as different stormwater and sanitary processes surrounding industrial and commercial uses.

Natural Infrastructure Systems

The fourth cornerstone, and arguably the most important in terms of the Urban Great Lakes Water Research Center, is the transformation of the city's public infrastructure. The City is expected to continue to lose population over the next 20 years (Detroit Future City, 2013). Therefore, it is critical to reorganize the city's systems to reduce service costs for the declining demand, while simultaneously anticipating future demand (Detroit Future City Plan, 2013). The framework stresses the importance of reducing the current utility budget

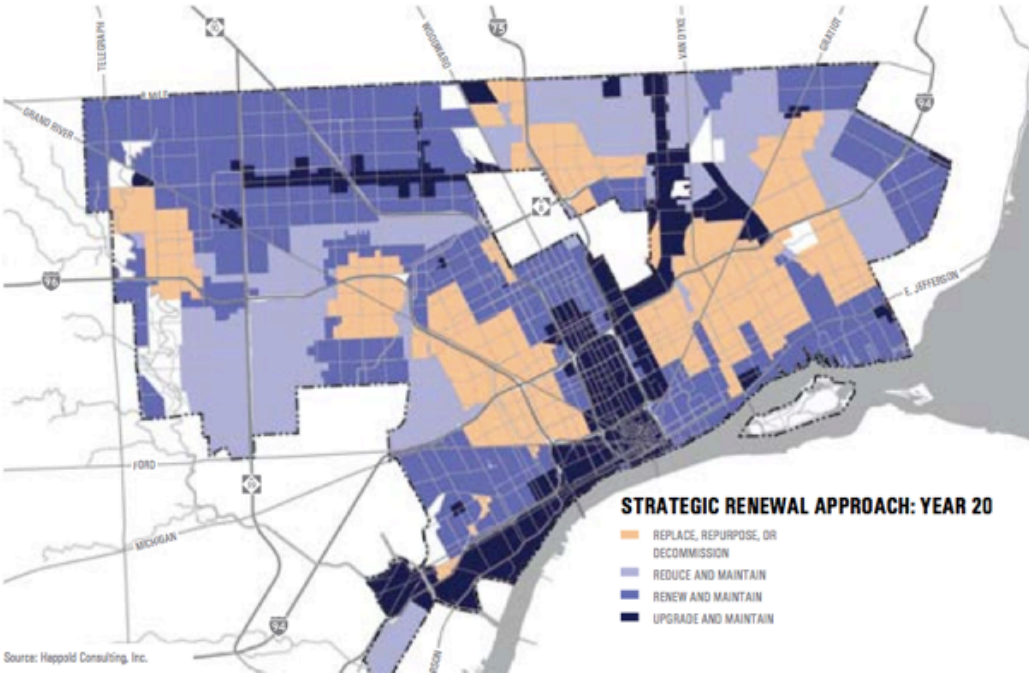
gap, reshaping the scale of services, and re-investing in infrastructure that is efficient and environmentally sustainable. Consequently, alternative forms of infrastructure are demanded, as well as replacement of existing infrastructure with innovative technologies: natural landscapes that clean air and water, in-situ gray water processes and alternative stormwater management, and storage systems that decrease delivery costs and preserve the Great Lakes ecosystem.

"...blue and green infrastructure involves a multitude of actors, from lawyers, technocrats, designers, and contractors; as such, the plan calls for these kinds of partnerships..."

The framework outlines strategies that integrate infrastructure systems and use the city's landscape for natural utility systems for stormwater management. The plan advocates for investment integration of different systems, i.e. coordinating investments and retrofits for water, waste, energy, transportation, and communication systems. The proposed investment approach for each system coincides with each land use, while quantifying the current and future demand levels with anticipated density, or lack thereof (Detroit Future City, 2013).

City System Upgrade and Renewal Approach

The map to the right depicts the framework's public system upgrades ,management and renewal. It is important to note the coordination of this map to the economic cluster map, as the renewal approach prioritizes renewal in the economic zones..



Source: Detroit Future City, 2013

Moreover, the plan supports landscapes as a tool for dealing with Detroit's environmental and public health hazards. The plan stresses the re-use of vacant land for green and blue infrastructure to naturally clean stormwater and improve air quality (Detroit Future City, 2013). The plan supports the notion that landscape systems typically cost less to build and maintain, creating additional economic benefits (Detroit Future City, 2013). Landscape infrastructure also facilitates collaboration between agencies and has regional benefits that could foster greater coordination and a infrastructure system re-

investment strategy that is regional in nature.

Finally, the plan provides implementation steps to facilitate system coordination. Specific to water and waste, the plan promotes Waste-to-Energy systems and composting as sources of alternative energy. The plan also advocates for efficient use of water through green, blue, and low-cost, long lasting sewer retrofits. Lastly, data infrastructure for the detection of leaks in piping is also crucial to minimize costs and understanding peak demand for certain services. Currently, there are several programs and researchers at regional universities that could be part of an Urban Great Lakes Water Research Center that could inform utility service delivery, monitoring of leaks, and reduce peak demand to lower service costs and expedite infrastructure maintenance.

Fostering Opportunity for an Urban Great Lakes Research Center

While the Detroit Future City plan is a testament to extensive public engagement and expert analysis, the plan fails to explicitly address water innovation and university collaboration as a strategy for economic diversification. The Great Lakes region is a regional hub for talent generation and research and development (R&D). The region comprised of Illinois, Wisconsin, Minnesota, Ohio, New York, Ontario, Indiana, Pennsylvania, New York, and Michigan are home to nearly 38% of all academic R&D (Austin, 2008). Further, the intensity of R&D at colleges and universities within the Great Lakes region accounts for 41% of regional GDP (Austin, 2008). Similarly, with 35% of the bi-national population in the Great Lakes region, the region produces 41% of bi-national graduates (Austin, 2008). In the United States, in 2003, 205,593 science and engineering degrees were awarded, of which 48,357 were in advanced degrees (Austin, 2008). Take together, this represents over 36 percent and 37 percent of United States totals, respectively (Austin, 2008).

These figures represent significant opportunity to retain and attract STEM employment opportunity. One strategy, implicitly outlined in the Detroit Future City Framework, is to foster opportunities for environmental scientists, landscape architects, civil and environmental engineers, hydrologists, etc. In particular, the re-use of land for green and blue infrastructure affords great opportunity to re-imagine, re-design, and innovate implementation practices for new land use typologies. Needed in this endeavor are talented designers, engineers, and planners to determine the appropriateness and location, and monitoring technology that measures the effectiveness of different infrastructures. Similarly, R&D into new technologies to alleviate the burden of the city's current utility infrastructure is crucial. Creating new wastewater and stormwater management process, monitoring the wastewater process, collecting sewage sludge for renewable energy, and cleansing and repair techniques are needed to reduce the burden of service delivery on the City

and its residents.

In short, the Detroit Future City Framework calls for water-based innovation that implicitly establishes the need for a center where design, R&D, and policy are synergistic. A physical place can serve as a space where not only innovation and synergy occurs, but also as a setting where dialogue is created between residents, the public and private sectors, and the scientific community. The Detroit Future City Framework and an Urban Great Lakes Water Research Center can also engage students and provide entrepreneurial opportunities that are based in the City of Detroit, thereby mitigating Michigan's "Brain Drain," fostering professional development, and attracting young, educated professionals to the Detroit region.

Appendix B

Models of Public-Private Partnerships

Public-private partnerships in the United States are primarily employed for the construction and provision of certain, large-scale public goods (Siemiatycki and Farooqi, 2012). In a recent article published by Siemiatycki and Farooqi (2012), they determined how project planners involved in public-private partnership's have structured, evaluated, and selected the preferred partnership model to realize Value for Money (VfM) in ex ante evaluations. The concept of VfM developed as a benchmark to assess the comparative advantages of using public-private partnership versus traditional procurement options.

Their study found that the net cost of traditional procurement models for 28 large-scale infrastructure projects in Ontario, Canada was less expensive than the public-private partnership model. However, the cost of risk to the public sector is less, and this is where VfM is identified. In the public-private partnership model, private debt and equity investment is the key driver. According to Siemiatcycki and Farooqi (2012), this ensures that the private-sector partner(s) have an incentive to manage the risks, because otherwise their return on investment could be in jeopardy.

Additionally, the authors evaluate how key planning concerns, including community participation, contractual obligations, and political preference influenced the outcomes of VfM in in the 28 public-private partnership projects and highlighted the implications for the project planner. Among such implications, the authors suggest the project planner might consider the following:

- Public release of complete ex ante VfM report before final approval. This facilitates a meaningful public participation process to debate and collect the merits of the public-private partnership to other procurement alternatives.

- The contractual obligations of the private sector. For example, short-term build-finance or design-bid-build contracts to incentivize the private-sector to manage project design and construction risks, while lowering public-sector risk and maintaining long-term control.

- Incorporation of additional "rebalancing clauses" into the concession

agreement, so that if the rate of return for the private-sector exceeds what is originally anticipated, the public sector partner shares in the excess return (Siemiatcycki and Farooqi 2012).

Furthermore, Garvin and Bosso developed a corollary framework to Campbell's "Planner's Triangle" to balance the interests of society, state, and industry and the market for ultimate success and effectiveness of United States infrastructure Public-private partnership programs and projects. Garvin developed the Equilibrium Framework to promote structured thinking of public-private partnership's. He assumed that any public-private partnership project might consider providing marginal improvement for quality of services, improved price and/or cost, decrease in time of service, mitigating the level of environmental impacts, and equal distribution of social benefits. He defines the state as the governing body over the jurisdiction. Society consists of the citizens living and working within the jurisdiction. Conversely, industry is the enterprise engaged in providing services (Garvin and Bosso 2008). Lastly, the market is the financial system allowing the transfer and exchange of wealth and risk.

Subsequently, Garvin and Bosso applied the equilibrium framework in a case-based research approach to evaluate if the equilibrium was achieved in 17 large infrastructure public-private partnership projects and programs throughout the United States. In doing so, they created a template to assess the impact of several project elements, including market conditions, socio-environmental conditions, acquisitions, contract management, and project performance. The impact of each element was assigned a certain direction within each quadrant of the equilibrium. The projects with particular significance saw a considerable amount of tension drifting towards industry interests. Therefore, the authors concluded that structural imbalances exist, resulting in high transaction costs and poor outcomes (Garvin and Bosso 2008).

Appendix C

A Timeline: History of the Great Lakes Region

The United States and Canada's prosperity is dependent upon the Great Lakes region. Therefore, it is imperative to understand salient events in the region's economic history.

In order to understand the extent to which the United States and Canada's prosperity is dependent upon the Great Lakes region, it is imperative to understand the region's history. From the Declaration of Independence in 1776 to the Great Lakes Legacy Act of 2010, there have been fundamental legislative actions, infrastructure improvements, and engineering advancements, coupled with significant environmental movements, that have shaped the current efforts for Great Lakes restoration and water-based innovation.

When aggregated, historical events are significant to understanding current efforts whether at the local, state, or federal level. The timeline highlights the region's salient historical events and is intended to provide a framework of the region's historical innovation trends.

SALIENT EVENTS IN THE ADVANCEMENT OF THE GREAT LAKES REGION

NATIONAL, STATE, & LOCAL LEGISLATION

1741 The Soo Locks in Michigan's Upper Peninsula is built by the French

1783 Treaty of Paris signed

1789 First President of the United States elected into office

1789 Constitution of the United States of America

1791 Ohio is incorporated as an official state of the United States

1808 The Erie Canal proposed by the New York State Legislature

1818 Illinois is incorporated as an official state of the United States of America

1824 Interstate Commerce Clause grants Congress power to regulate interstate commerce

1846 Michigan is incorporated as an official state of the United States of America

1848 Wisconsin is incorporated as an official state of the United States of America

1854 First bi-national agreement for reciprocity in emerging industries (U.S. & Canada)

1858 Minnesota is incorporated as an official state of the United States of America

1862 Morrill Land Grant Act enabled the creation of land-grant universities in the U.S.

1867 The creation of the Dominion of Canada

1872 The U.S. Homestead Act and Canadian Dominion Lands Act

1882 Navigable Waters Protection Act enacted by the Canadian Parliament

1909 Boundary Waters Treaty Act signed by both Canadian and U.S. government

1934 Trade Agreements of 1934; President delegated as negotiator for trade agreements

1968 Established the Great Lakes Basin Compact

1972 Great Lakes Water Quality Agreement

1985 Great Lakes Charter established to restrict water withdrawals

1986 Water Resources Development Act

2001 Annex 1 of the Great Lakes Charter; a bi-national water management system

2002 Great Lakes Legacy Act: appropriation $270 million for Great Lakes restoration

2011 Innovate America Act introduced to United States Congress

KEY ACTORS & EVENTS

1783 George Washington elected as the first President of the United States

1789 The Constitution outlines the powers of the Federal government

1789 The Bill of Rights outlines the first ten amendments of the U.S. Constitution

1791 NY State approval to fund a survey for the proposed Erie Canal route

1808 Welland Canal constructed, connecting the St. Lawerence river to the Great Lakes

1817 The construction of the Erie Canal completed.

1824 Wheat and timber are staple export crops throughout the Great Lakes region

1825 The construction of the Tideau Canal linked Ottawa and the Great Lakes

1832 The first mid-western railroad tracks in the City of Chicago

1840 Great Lakes settlement unearthed mineral deposits and oil production

1848 Completion of the Canadian-Pacific Railway, linkage b/t Canada and the U.S.

1858 Reversed the flow of the Chicago River, linked the Mississippi to the Great Lakes

1885 New migrants to the region spurred industrial and urban development

1900 Creation of the International Joint Commission to negotiate cross-border disputes

1909 Henry Ford perfects the assembly line and builds the Model T

1910 The creation of the International Joint Commission

1910 Marked the beginning of the Great Migration

1965 Rachel Carson publishes "Silent Spring," initiating the U.S. environmental movement

1968 Cuyahoga River goes up in flames due to high phosphorous levels

1970 Alliance for the Great Lakes is founded to create a citizen monitoring system

2004 Great Lakes Restoration Initiative founded for the promotion and restoration of the Great Lakes

2005 Brookings Institute creates the Great Lakes Economic Initiative via John Austin

2009 President Obama allocates $475 million towards the restoration of the Great Lakes

2010 The Great Lakes Restoration Initiative releases Action Plan, outlining AOC's and priorities

2013 Detroit Future City plan is released, outlining the priority for green and blue infrastructure

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