Cost and Benefit Analysis of Blackstone Canal Revitalization

WORCESTER POLYTECHNIC INSTITUTE:
INTERACTIVE QUALIFYING PROJECT
DECEMBER 18, 2014

Sponsor

JOHN GIANGREGORIO: PRESIDENT BLACKSTONE CANAL DISTRICT ALLIANCE

Advisors

ANNE OGILVIE AND COREY DEHNER

Robert Crimmins
John Messier
Daniel Ouellette
Nicholaus Spunar

Acknowledgements

We would like to thank members of the Blackstone Canal District Alliance for their accommodation throughout our project. We would also like to thank our advisors, Corey Dehner and Anne Ogilvie, as well as our sponsor, John Giangregorio, for assisting us in our research. Lastly, we would like to thank all the individuals who helped us with our cost and benefit assessment of revitalizing the Blackstone Canal in Worcester, Massachusetts.

Abstract

In 1828, the Blackstone Canal in Worcester, Massachusetts catalyzed bringing the city from a farm town into the American Industrial Revolution. Due to the development of the railroad, the Canal was covered up and eventually tied into Worcester's sewer system. The Blackstone Canal District Alliance is a non-profit organization in Worcester that promotes the economic development of the city. The goal of this project was to provide the Alliance with a cost and benefit assessment of revitalizing the Blackstone Canal for its half mile stretch from Union Station to Kelley Square. Based on data taken from sources in fields of economics, urban planning, and politics, we developed such an assessment and provided the alliance with recommendations for further pursuit of their vision.

Executive Summary

The Blackstone Canal District Alliance, a non-profit organization in Worcester, Massachusetts, envisions a multi-use destination neighborhood for both tourists and residents to appreciate the history, culture, and businesses in the Canal District of Worcester. The Mill Brook section of the Blackstone Canal flows under Worcester's Harding Street. The Alliance is building support for a revitalization of the Blackstone Canal and believes it will serve as a catalyst for economic growth. The Alliance tasked us with performing a cost and benefit analysis for the two main options of revitalizing the Blackstone Canal, restoration and replication.

Restoring the Blackstone Canal would involve unearthing the existing Canal, isolating it from city infrastructure, and then repairing it to pristine condition. Replication of the Blackstone Canal is another option for revitalization. The replication process would entail duplication or reproduction of the Blackstone Canal on top or to the side of the existing Canal.

Background

The term urban blight describes the decrepit appearance of a city, or area of a city, that has experienced economic hardships (Gordon, 2003). Urban renewal projects are designed to reverse the rate of economic decline and urban blight within a city. This process is known as economic revitalization, which is defined as increased economic and aesthetic development within a city (Breger, 1967). One tactic for combating urban blight involves public officials and urban planners designing projects that bring economic and aesthetic development to a blighted city (Groberg, 1965). Cities have funded projects that develop vibrant urban centers and offer a variety of recreational activities, such as dining and shopping, in order to attract tourists as well as community residents (JÓKÖVi, 1992).

The Blackstone Canal District Alliance is focused on increasing economic activity and development in Worcester. Specifically, the Alliance wants to stimulate economic growth by revitalizing the Blackstone Canal in the city of Worcester, Massachusetts.

Since discussion of Blackstone Canal revitalization started, city planners, environmentalists, conservationists, and historians have had various opinions on which option for revitalization is the best for the city of Worcester (Magiera, 1999). In 2003, ICON Architecture Inc. conducted a feasibility study in which they analyzed the costs and benefits of a revitalized Blackstone Canal in Worcester ("Free the Blackstone," 2003). The Alliance believes the next step is to conduct an updated and unbiased analysis of the costs and benefits of both a restoration and a replication of the Blackstone Canal to illustrate that canal revitalization is a worthy investment (Giangregorio, 2014).

Methodology

The goal of our project was to conduct an unbiased cost and benefit assessment of both restoring and replicating the section of the Blackstone Canal that runs under Harding Street in Worcester, Massachusetts. In order to complete this goal we developed the following five objectives:

1) Identify relevant stakeholders of a Blackstone Canal restoration or replication;
2) Identify the costs and benefits associated with restoration of the Blackstone Canal;
3) Identify the costs and benefits associated with replication of the Blackstone Canal;
4) Analyze potential costs and benefits related to a Blackstone Canal revitalization in Worcester; and
5) Develop recommendations for the more beneficial revitalization effort.

In order to complete these objectives we researched similar waterway revitalization projects from across the country, including: the Capital Center Project in Providence, Rhode Island; the Bricktown Canal in Oklahoma City, Oklahoma; the in-progress Canalside project in

Buffalo, New York; the Canalway and Riverwalk in Lowell, Massachusetts; the Canal Walk project in Indianapolis, Indiana; and the River Walk project in San Antonio, Texas.

As part of our research, we interviewed decision makers and other knowledgeable individuals. We define a *decision maker* as any individual or group that could have a say on planning, funding, or other general decision making regarding a revitalization of the Blackstone Canal while *knowledgeable individuals* include people who could help our group identify costs and benefits associated with revitalizing the Blackstone Canal. Decision makers consisted of urban planners, city officials, members of Congress, and state representatives. Knowledgeable individuals consisted of historians, cultural experts, members of the Blackstone Canal District Alliance, employees of the Department of Public Works, employees of the Department of Transportation, economic development professionals, and tourism industry professionals. We interviewed these stakeholders in Worcester as well as aforementioned cities that have conducted similar waterway revitalization projects in order to help us identify and analyze costs and benefits associated with both a restoration and a replication of the Blackstone Canal. Furthermore, we analyzed our data to assess whether a restoration or a replication of the Blackstone Canal would be a more beneficial option considering the economic, social, and historical implications for the city of Worcester.

Findings and Recommendations

In order to deduce relevant findings, we analyzed the economic, social, and historic benefits of similar revitalization projects in order to show the potential impact of a Blackstone Canal revitalization in Worcester. These benefits include: increased tourism, domino effect of further private investment, increased property values, increased property taxes, quality of life, and increased aesthetic appeal. We also compared the costs and benefits of both a replication and

restoration of the Canal in order to determine which option would be more beneficial to Worcester.

Increased Tourism

Increased tourism due to similar waterway revitalization projects shows the potential economic impact a Blackstone Canal revitalization could have in Worcester. Through content analysis and contact with professionals from tourism bureaus and organizations, we analyzed the impact of increased tourism in similar cities as a direct result of the various waterway revitalization projects. Figure 1, right, shows a graph of hotel occupancy in Providence, Rhode Island for the summer months of 2014. The higher weekend occupancy shows that Providence is more of a tourist destination than business center. This finding was supported by Martha Sheridan, the president and CEO of the Providence and Warwick Convention and Visitors Bureau. Sheridan expressed that the Capital Center Project in Providence, which included Waterplace Park, allowed the city to transition from a weekday business center to a weekend tourist destination.

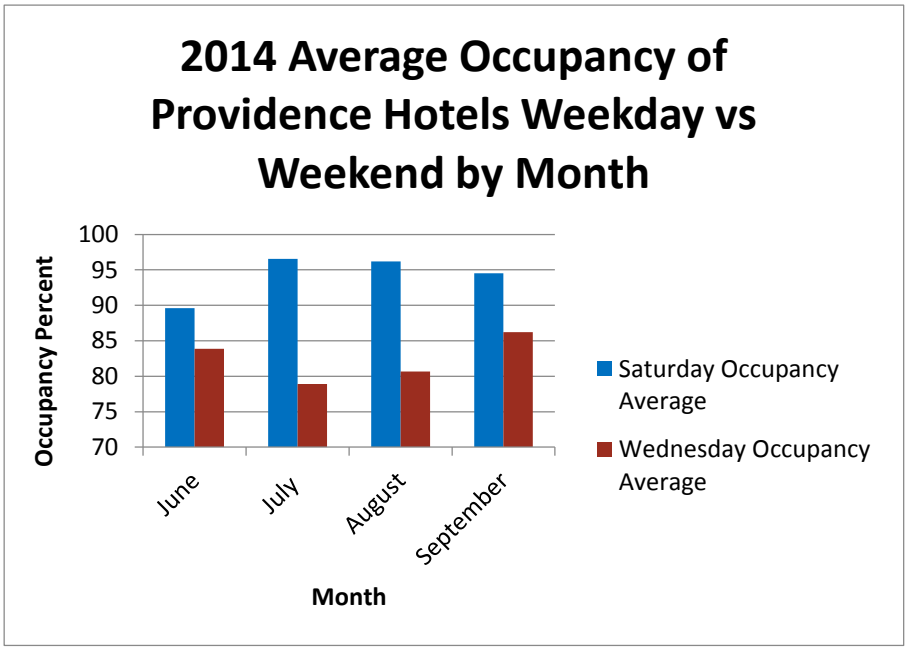


Figure 1: 2014 Wednesday vs Saturday Hotel Occupancy Providence, Rhode Island (STR Inc., 2014)

Domino Effect of Further Private Investment, Increased Property Value and Tax Revenue

Further private investment following the completion of similar waterway revitalization projects shows the potential economic impact a Blackstone Canal revitalization could have in Worcester. Professionals we interviewed in similar cities felt their respective waterway revitalization projects initiated public and private investment in the surrounding areas. The construction of these waterways attracted potential investors and developers to restore and reutilize old buildings or create new construction projects in other cities. Furthermore, these investments increased the property values and property tax revenue to the respective cities. The increased investment in Oklahoma City and Providence are shown in Table 1, below, along with the projects in Buffalo, Lowell, and San Antonio.

Table 1: Private Investment in Similar Cities

Project	Private Investment
Capital Center, Providence	$1.2 billion (as of 2014)
Bricktown Canal, Oklahoma City	$109 million (as of 2009)
Canalside, Buffalo	$305 million (as of 2014)
Canalway Riverwalk, Lowell	$527 million (as of 2011)
River Walk, San Antonio	$253 million (as of 2009)

Furthermore, a 2009 study, conducted by Larkin Warner, Ph.D in economics, for Oklahoma City's Chamber of Commerce, analyzed 23 commercial properties in the Bricktown District of Oklahoma City. The study showed a 337% increase in these property values between when the Canal was completed in 1999 ($10.8 million) and 2004 ($36.3 million) (Warner, 2009). While other factors may have contributed to these increased property values and subsequent tax revenue, Warner's study suggests that the implementation of a waterway in Bricktown is, at least partly, responsible for these increased values.

Increased Quality of Life

Quality of life improvements were a recurring theme in cities that had undertaken similar projects. By increased quality of life we are referring to the increased enjoyment residents in the area can expect to experience as a result of the Blackstone Canal revitalization. The waterway revitalization that had the most evidence to support improved quality of life was the River Walk in San Antonio. Out of 186 people residing in Bexar County, Texas who visited River Walk, 30% said they came for the quality of the experience and 16% said they came for the value of the experience. From this we can deduce that just over 40% of the Bexar County residents surveyed went to the River Walk because they thought they would enjoy their experience. If you take the entire survey as a whole, 167 people or 89.78% came to the area of the water feature for some sort of experience that would enhance their quality of life. Figure 2, below, shows the results of this study.

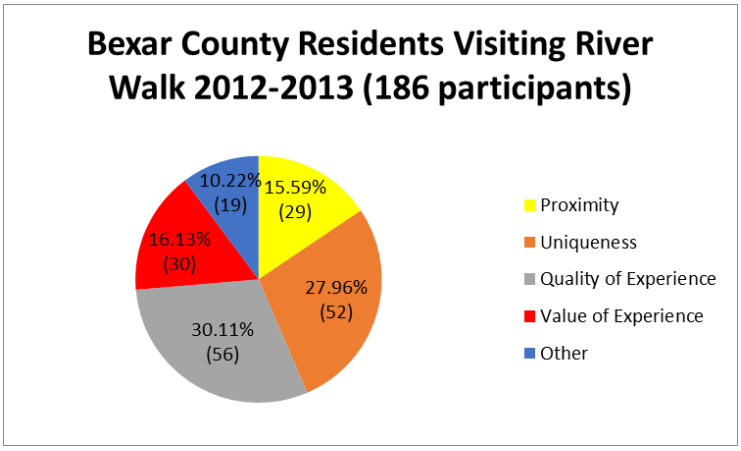


Figure 2: Bexar County Residents Visiting River Walk (Nivin, 2014)

Increased Aesthetic Appeal

Increased aesthetic appeal due to similar waterway revitalization efforts show potential impact in Worcester. Oklahoma City's Bricktown Canal, for example, helped transform and

revive the Bricktown area into a “vibrant community center” as seen below in Figures 3 and 4 (Carpenter, 2014).

Figure 3: Bricktown Canal Before (Carpenter, 2014)

Figure 4: Bricktown Canal After (Carpenter, 2014)

Harding Street in Worcester, Massachusetts has several blighted areas that would benefit from the increased visual appeal a revitalized Blackstone Canal would potentially bring.

Events and Programming Along Similar Waterways

Events and programing along similar waterway revitalizations and construction projects maximize the potential of a revitalized waterway. Examples of these events can be seen in Figures 5 and 6, below, which show the WaterFire Festival in Providence and the Water Taxi tours in Oklahoma City. Figure 5, depicting WaterFire in particular shows a large number of residents and tourists who visited Waterplace Park in order to attend the festival.

Figure 5: WaterFire: Providence, Rhode Island

(Photo taken 11/8/14)

Figure 6: Water Taxi Tour (oklahomablogger.com)

Restoration v. Replication

In the following section we compare a restoration and replication of the Blackstone Canal in Worcester. We discuss the associated costs of both options as well as any benefits applicable to each option. This comparison allowed us to determine which option would be more feasible for the city of Worcester.

State of Blackstone Canal, Combined Sewer Overflow System

Commissioner of the Department of Public Works for Worcester, Massachusetts, Paul Moosey, explained how Worcester utilizes the Mill Brook section of the Blackstone Canal under Harding Street as a storage tank to aid the water treatment process during increased storm water collection. This system is known as a Combined Sewer Overflow system, or CSO. A Combined Sewer Overflow system is a single "pipe" that collects rainwater runoff, domestic sewage, and industrial wastewater (Environmental Protection Agency, 2014). After a tour of the water treatment facility on Quinsigamond Avenue in Worcester, we learned that the Canal is necessary

for helping the plant meet Environmental Protection Agency standards for discharging treated water.

Restoration Costs

Paul Moosey claimed that a restoration of the Blackstone Canal would be significantly more difficult to implement than a replication. When taking into consideration the complexity of the Combined Sewer Overflow, and structural integrity of the existing Canal once uncapped and unearthed, the costs would be on the magnitude of hundreds of millions of dollars. If the CSO was not an issue, he claimed a restoration may be equivalent or less expensive than a replication. Between saving money in excavation and concrete costs and applying it towards the cleansing of the bricks and supporting the structure, the costs of a restoration would be comparable to the cost of a replication. Considering Worcester's existing funds, and the functional practicality of the Canal as a CSO for the city of Worcester, Moosey did not believe restoration is feasible enough to do a proper restoration assessment.

Replication Costs

Paul Moosey helped us estimate costs of replicating the Blackstone Canal. We also contacted Wachusett Precast Inc. to obtain approximate material costs of a replication. Furthermore, we utilized a 2003 feasibility assessment titled "Free the Blackstone," conducted by ICON Architecture, and applied an inflation factor to all existing values to estimate an adjusted inflation price. Using this assessment we calculated the replication cost to be approximately $19,204,791. The rest of the estimates can be seen in Table 2, below.

Table 2: Seven strategies for estimating replication costs

	Paul Moosey Approx. (W/ Streetscape Inflation)	Paul Moosey Approx. (W/ Modern Streetscape)	Wachusett Precast (W/ Median Modern Bid)	Wachusett Precast W/ Mean Modern Bid	Feasibility Assessment Inflation (With Inflation)	Modern Bid Pricing Updating (Median Values)	Modern Bid Pricing Updating (Mean Values)
Waterway Implementation	$7,920,000	$7,920,000	$14,282,375	$14,269,183	$10,585,005	$18,539,822	$18,526,630
Cushion	15%	15%	15%	15%			
Construction Contigency	15%	15%	15%	15%			
Utility Contingency	10%	10%	10%	10%			
Streetscaping	$776,188	$1,900,000					
Inflation					129.36%		
Detailed Master Plan			2%	2%	2%	2%	2%
Engineering / Architecture Costs			10%	10%	10%	10%	10%
Contingency					25%	25%	25%
Total	$12,297,809	$13,421,620	$23,312,113	$23,290,581	$19,204,792	$26,002,100	$25,983,600

Creating statistics from all of these different assessments gave us the best estimation on the potential cost of replicating the Blackstone Canal, while minimizing our percent error in each direction. The arithmetic mean of the collection of cost estimates would be one interpretation of our calculated data for the cost of replication of the Blackstone Canal. The range, mean, and median of our cost estimation can be seen in Table 3, below.

Table 3: Range, Mean, Median values for replication estimated costs

Range	$13,704,291
Mean	$20,501,802
Median	$23,290,581

Historical Authenticity

A replication of the Blackstone Canal rather than a restoration would not detract from the amount of visitors a revitalized Canal could expect to see. Susan Ceccacci from Preservation Worcester, Chuck Arning from the National Park Service, Bill Wallace from the Worcester Historical Museum, and multiple members of the Blackstone Canal District Alliance agree that, while a restoration would be preferred, a replication of the Canal could be just as successful at promoting the Canal's role in history. Using materials that would imitate the original stonework

would ensure that a replication look historically authentic. Also, these professionals agreed that small historical exhibits or features along the Canal could further promote the Canal's role in the Industrial Revolution.

Replication Benefits

Replicating the Canal at street level rather than restoring the Canal below street level could maximize visitor expenditures at businesses along Harding Street. Both a replication and a restoration of the Blackstone Canal would lead to an increase in visitor spending in Worcester, especially at potential retail businesses and restaurants along Harding Street. Chuck Arning from the National Park Service felt a replication in particular would maximize visitor spending along the Canal. According to Martha Sheridan of the Providence Warwick Convention and Visitors Bureau and the Economic Development Office in Indianapolis, other waterway revitalization efforts such as the Canal Walk in Indianapolis and Waterplace Park in Providence did not reach their full potential on a retail front due to the fact that both water features run below street level. A water feature on street level in Worcester would ensure anyone walking along the Canal would be exposed to all the potential storefronts and dining options. A restored Canal would not allow for a water feature on street level. Therefore, a restored Canal could possibly limit the development of successful retail and other business along Harding Street.

Replication would allow for more flexibility in the design and construction of both the Canal and the surrounding streetscape. A restoration and a replication of the Canal in Worcester would benefit the overall look and feel of the surrounding area, however a replication allows for the flexibility to get creative in the design of the water feature. Many public officials such as Jeannie Hebert, the President of the Blackstone Valley Chamber of Commerce, Martha Sheridan, the President and CEO of the Providence Warwick Convention and Visitors Bureau, and

National Park Service Park Ranger Chuck Arning felt that the up close interaction with the water would be better exhibited in a replication rather than a restoration.

Recommendation

Due to the extenuating cost of separating the CSO system, all the benefits that would come with both a restoration and a replication of the Blackstone Canal, and several benefits that favor a replication over a restoration, our group recommended that the Blackstone Canal District Alliance and the city of Worcester promote a clear vision of a replication of the Blackstone Canal along Harding Street. A single vision of the final product would allow for the Alliance, Worcester Municipal Government, and the Worcester Community to be on the same page and would allow for more focused discussions on the revitalization in the future.

Table of Contents

List of Tables

List of Figures

Authorship

Section	Author
Authorship	Daniel Ouellette
Acknoledgements	Daniel Ouellette
Abstract	Nicholaus Spunar
Executive Summary	All
List of Figures	Daniel Ouellette
List of Tables	Daniel Ouellette
Chapter 1: Introduction	Robert Crimmins & John Messier
Restoration of the Blackstone Canal	Robert Crimmins & John Messier
Replication of the Blackstone Canal	Robert Crimmins & John Messier
Cost and Benefit Analysis of the Blackstone Canal Revitalization	Robert Crimmins & John Messier
Chapter 2: Background	All
2.1 Urban Blight	Robert Crimmins
Economic Opportunity, Population, and Industrialization	Robert Crimmins
2.2 Economic Revitalization	Nicholaus Spunar
Eastern United States	Nicholaus Spunar
Indianapolis, Indiana	Nicholaus Spunar
Southern United States	Nicholaus Spunar
International Revitalization Efforts	Nicholaus Spunar
2.3 Current State of Worcester, Massachusetts	Robert Crimmins
2.4 Blackstone Canal District Alliance	John Messier
2.5 History and Current State of the Blackstone Canal	John Messier
2.6 Blackstone Canal Revitalization	Daniel Ouellette
Cost and Benefit Analysis	Daniel Ouellette
2.7 Analysis of Blackstone Canal Restoration/Replication	Daniel Ouellette
Chapter 3: Methodology	Daniel Ouellette & Nicholaus Spunar
3.0 Introduction	Daniel Ouellette & Nicholaus Spunar
3.1 Objectives	Daniel Ouellette & Nicholaus Spunar
Objective 1: Identify Stakeholders in a Blackstone Canal Restoration or Replication	Daniel Ouellette & Nicholaus Spunar
Objective 2: Identify Associated Costs and Benefits of Restoration of the Blackstone Canal	Daniel Ouellette & Nicholaus Spunar
Objective 3: Identify Associated Costs and Benefits of Replication of the Blackstone Canal	Daniel Ouellette & Nicholaus Spunar
Objective 4: Analyze Potential Costs and Benefits of a Revitalized Blackstone Canal	Daniel Ouellette & Nicholaus Spunar
Objective 5: Develop Recommendations for the More Beneficial Revitalization Effort	Daniel Ouellette & Nicholaus Spunar
3.2 Obstacles in Collecting Data	Daniel Ouellette & Nicholaus Spunar
Chapter 4: Findings and Recommendations	All
I. Comparison to similar waterway revitalization projects	Daniel Ouellette & Nicholaus Spunar
a. Increased tourism	Daniel Ouellette & Nicholaus Spunar
b. Domino effect of further private investment, increased property values and tax revenue	Daniel Ouellette & Nicholaus Spunar
c. Quality of life	Daniel Ouellette & Nicholaus Spunar
d. Increased aesthetic appeal	Daniel Ouellette & Nicholaus Spunar
e. Events and programming along the waterway	Daniel Ouellette & Nicholaus Spunar
II. Blackstone Canal restoration versus replication	All
a. State of the Canal, Combined Sewer Overflow (CSO) system	Robert Crimmins
b. Restoration Costs	Robert Crimmins
c. Replication Costs	Robert Crimmins
d. Historic Significance	John Messier & Daniel Ouellette
e. Replication Benefits	John Messier & Nicholaus Spunar
III. Recommendations	Daniel Ouellette
a. Recommendation 1: Assess feasibility of CSO rerouting	Daniel Ouellette
b. Recommendation 2: Establish one vision and design for the Blackstone Canal replication	Daniel Ouellette
c. Recommendation 3: Assess community and business support	Daniel Ouellette
Conclusion	Nicholaus Spunar
References	All
Appendix A: Knowledgeable Person Interview Template	All
Additional Questions for Professionals of Similar Projects	All
Appendix B: Politician Interview Template	All
Appendix C: Historian Interview Template	All
Appendix D: Interviewees	All
Appendix E: Geographic Information System Diagram, Harding Street, Worcester, MA	All
Appendix F: 32 Pump Stations in Worcester, MA	All
Appendix G: Mean and Median Average Bid Prices	All

Chapter 1: Introduction

The Blackstone Canal District Alliance, a not-for-profit organization in Worcester, Massachusetts, envisions a multi-use destination neighborhood for both tourists and residents to appreciate the history, culture, and businesses in the Canal District of Worcester. Figure 1, below, illustrates how the future renovations to the Blackstone Canal District might look. The Blackstone Canal flows under the city's roads, sidewalks, and parking lots. The Alliance is building support for a restoration or replication of the Blackstone Canal and believes Canal revitalization will serve as a catalyst for economic development of the city.

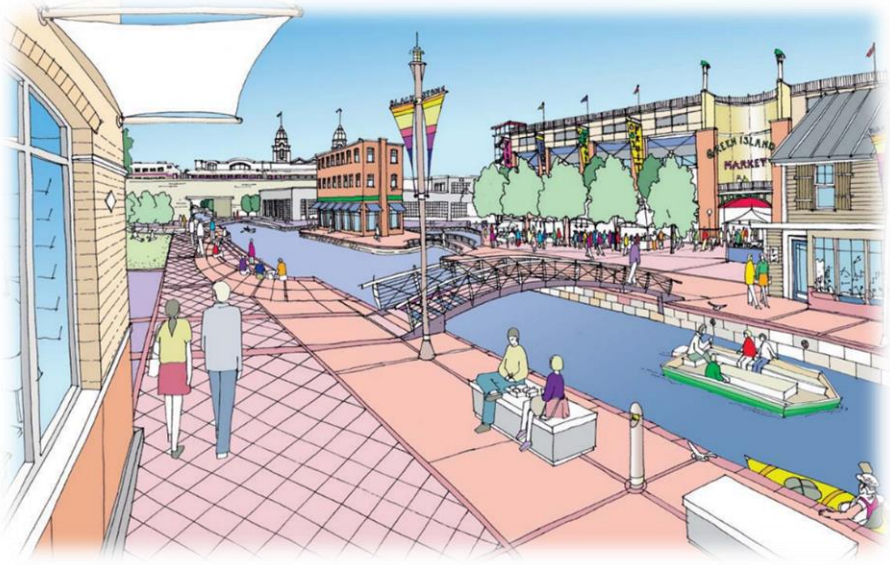


Figure 1: Proposed Concept for Blackstone Canal (Free the Blackstone, 2003)

Restoration of the Blackstone Canal

Restoring the Blackstone Canal would involve unearthing the existing canal, isolating it from city infrastructure, and then repairing it to pristine condition. Complete replacement of sections and restoration of other sections would be expensive to implement due to possible obstacles which we discuss in Section 4 below. Several members of the Alliance support restoration because of the historical significance of the Canal (Giangregorio, 2014). Through the industrial revolution the Canal facilitated transportation of goods to Worcester allowing for

expedited manufacturing of materials and textiles (Greenwood, 2006). Although the Alliance believes restoration would be economically and culturally beneficial for the city of Worcester, it is likely to come with a substantial price tag. Consequently, the Blackstone Canal District Alliance has tasked us with conducting an independent cost and benefit analysis of the revitalization.

Replication of the Blackstone Canal

Supporters of the Blackstone Canal restoration offer another viable solution, known as replication. The replication process would entail duplication or reproduction of the Blackstone Canal experience. Without the additional costs of repairing the older canal, replication may be a more feasible financial undertaking. Aspects such as a lower cost and less construction time, favor a replication over a restoration. However, the feasibility, cost and level of community support for restoration or replication are still unknown.

Cost and Benefit Analysis of the Blackstone Canal Revitalization

The goal of our project was to provide an unbiased cost-benefit analysis of implementing either a restoration or replication of the Blackstone Canal. In order to accomplish this goal, we worked to identify appropriate stakeholders and professionals that could help us analyze costs and benefits of such a project. We analyzed comparable revitalization efforts of similar scale conducted in other communities, and performed a cost-benefit analysis of the revitalization efforts to be performed on the Blackstone Canal in Worcester. At the conclusion of our project, we provided the Blackstone Canal District Alliance with an assessment of our findings and our recommendations for how to proceed. Assessing metrics of tourism and economic growth, we analyzed whether this project could economically, socially, and culturally revitalize the Blackstone Canal District in a cost-effective manner.

In the following chapters we discuss background related to our topic and the methods we used to complete our cost and benefit analysis. In chapter 2, we explore issues associated with urban blight and how some cities are working to combat it. Also in chapter 2, we describe the economic condition of Worcester, Massachusetts and the Blackstone Canal District Alliance's belief that Canal revitalization will lead to economic development in the city. In chapter 3, we introduce the goal of our project and the objectives we accomplished in order to achieve our project goal. In this chapter we detail the research methods we used to conduct an unbiased cost and benefit analysis on the restoration or replication of the Blackstone Canal. In chapter 4 we discuss our findings and subsequent recommendations for the Blackstone Canal District Alliance.

Chapter 2: Background

2.0 Introduction

Urban blight is a term that can be used to describe a once thriving, industrial city that has fallen into a state of visual and economic destitution (Gordon, 2003). Cities design urban renewal projects in order to combat urban blight by improving the visual and economic appeal of an urban area (Groberg, 1965). In section 2.1, we discuss the meaning and causes of urban blight. Next, in section 2.2, we explore strategies for revitalizing urban centers. In section 2.3, we investigate the need for economic revitalization in Worcester, Massachusetts. In section 2.4, we provide a brief history and the mission of one organization working to revitalize the city, the Blackstone Canal District Alliance. In section 2.5, we discuss the history of the Blackstone Canal and its current state. In section 2.6, we analyze the revitalization of the Blackstone Canal as a strategy for bringing urban renewal to Worcester. Lastly, in section 2.7, we illustrate how a cost and benefit analysis is needed before the project of restoring or replicating the Blackstone Canal can make any headway.

2.1 Urban Blight

The term urban blight describes the decrepit appearance of a city, or area of a city that has experienced economic hardships (Gordon, 2003). Detroit, Michigan is an example of a city plagued with urban blight as evidenced by Figure 2, where a building is left to deteriorate into a

Figure 2: Building in Detroit, Michigan (Detroit's Decline, 2014)

state of disrepair. In the following sections we discuss the causes of urban blight including the loss of economic opportunities in a city, population, and deindustrialization.

Economic Opportunity, Population, and Industrialization

David Galenson, a professor of Economics at The University of Chicago, describes ideal economic conditions for large- and small-scale commercialization in Chicago during the American Industrial Revolution, which occurred between 1810 to 1910 (Galenson, 1991). Chicago was founded in 1833, and was one of the quickest growing cities in the world (Chandler, 1987). Businessmen, workers, and residents were looking to expand economic opportunity by moving to cities planned around technology innovation. Innovations such as the railroad changed the way people worked, traded goods, and traveled the country (Tinerella, 2005). Railroads were constructed through Chicago in 1848, and the city quickly became a centralized hub for transportation. During this time period, there was a shift of people moving westward to seek economic opportunity and an improved quality of life (Roger, 1993). There were some exceptions to the general westward movement of people including cities such as New York City, New York; Chicago, Illinois; and Philadelphia, Pennsylvania; which maintained a large, and increasing, population during the start of the 19th century (United States Census Bureau, 2013; Chandler, 1987).

Since the early 1800s, railways started replacing waterways because trains were capable of moving larger volumes of people, manufactured goods, materials, and textiles. Cities located near bodies of water had the advantage of ship-accessible ports and trans-Atlantic trade. Other cities, like Chicago, had high accessibility to trade routes due to the centralized railroad network feature (Chandler, 1987).

Cities that had a large volume of trade because of access to waterway transportation had competition from industries booming in Chicago, New York City, and Philadelphia. Business financial representatives determined their companies would be more successful by minimizing cost of manufacturing, or increasing their profit margin by minimizing transportation costs. Some companies were also able to manufacture items less expensively by manufacturing in bulk. Bulk manufacturing, or large-quantity manufacturing, became more common with the innovation of the train and the railroad network because larger volumes of materials could be transported between cities (Rowthorn & Ramaswamy, 1999). Businesses became larger, physically and economically, buildings became taller, and manufacturing speeds increased during the Industrial Revolution. All of these urban environment achievements contributed to increased employee density, population density, and economic activity (Galenson, 1991).

With all of the economic success going on in other parts of the United States, companies began leaving cities that were constructed around older transportation methods, such as waterways or horse-drawn travel routes (Reynolds, 1981). The buildings that were once filled with machining equipment and maintained by employees were sold to third party consumers (Breger, 1967). While major manufacturing cities such as Chicago and Philadelphia continued to thrive and develop, smaller city businesses and manufacturing operations suffered from financial hardship due to competition. Some of the previously abandoned properties were repossessed by financial institutions and banks (Olney, 1999). Many facilities required repairs and maintenance that exceeded the appraisal of the property. If the buildings and warehouses were restored to working conditions, cities may have surpassed their operational budget, or had to increase taxes. Neither of these options seemed viable with unemployment and poverty rates rising in cities with reduced economic activity (Breger, 1967).

Towards the end of the Industrial Revolution, the United States was an economic power, until 1925 to 1929 (Eichengreen, 2004). During this four-year period, the New York Stock Exchange, located on Wall Street, in Manhattan, experienced a financial crash. Many companies and businessmen entered financial hardship and filed for bankruptcy, running out of money, or desperately selling their homes and businesses at low prices to pay back broker loans (Olney, 1999). Cities that were experiencing less economic activity during the Industrial Revolution were greatly affected by the Stock Market Crash of 1929, and the Great Depression. In an attempt to save money, cities such as Detroit, Michigan, left buildings to deteriorate instead of repairing them. Figure 2, above, shows a deteriorating building in Detroit (NY Times, 2014). When building and infrastructure rot and decay is abundant, urban planners may classify sections of a city to be experiencing "Urban Blight," or "Urban Decay" (Breger, 1967).

Detroit, Michigan, was beginning to show signs of urban blight in the 1960s, especially after the Riot of 1967. The Riot of 1967 resulted in many buildings along 12th Street in Detroit being burned. These charred remains accelerated the deteriorated appearance of many buildings (Boyle, 2001). Unemployment, poverty, and deindustrialization plagued Detroit, and in 1976, at the peak of urban decay, 800 establishments were abandoned per month, leading to thousands of uninhabited and destroyed homes, businesses, and warehouses (Boyle, 2001). Detroit's deterioration was too quick to reverse. As of September, 2014, Detroit still remains heavily deindustrialized and in a deteriorated condition (NY Times, 2014).

Certain tactics can reverse the rate of economic decline. If carried out successfully, cities can recover from a state of urban blight. This tactic is known as economic revitalization, which is defined as increased economic and aesthetic development within a city (Breger, 1967).

2.2 Economic Revitalization

One strategy for combating urban blight involves public officials and urban planners designing projects that bring economic and aesthetic development to a blighted city (Groberg, 1965). Several cities have funded projects developing vibrant urban centers offering a variety of recreational activities, such as dining and shopping, in order to attract tourists as well as community residents (JÓKÖVi, 1992). In the following sections we describe the urban renewal efforts of Buffalo, New York; Indianapolis, Indiana; San Antonio, Texas; and Providence, Rhode Island. We also look at an international urban renewal effort in the United Kingdom.

Eastern United States

Buffalo, New York's Canalside project is a waterway restoration effort based on the historical significance of the Erie Canal that brings economic development to the city of Buffalo ("Historic Canalside," 2014). According to the Erie Canal Harbor Development Corporation, a state agency of New York created by New York State Governor Andrew Cuomo, as of November 2010, the Canalside project was expected to require approximately $315 million in public and private investments ("Erie Canal," 2014). According to the city of Buffalo, as of 2014 the completed project only cost $295 million ("Historic Canalside," 2014). The project created tourist attractions such as the old Erie Canal locks and towpaths, ice-skating, canal boat rides, restaurants, different shopping venues, and historical museums ("Erie Canal," 2014).

Based on projections made in October 2010, the project was expected to create approximately one-thousand new jobs as well as bring in about $9.5 million in annual sales tax and $1.2 million in city property taxes for the city of Buffalo ("Erie Canal," 2014). A 20 year forecast also shows $189 million in sales tax revenue over the period ("Erie Canal," 2014).

Public officials and urban planners in Providence, Rhode Island completed a restoration of the previously covered up Blackstone Canal to promote economic and social vitality in the city (Nicholson, 2002). Waterplace Park features attractions that promote tourism such as boat tours, restaurants, historical tours, and public events (Waterplace Park, 2008). One example of how Providence uses its waterway to build tourism is its Waterfire festival as depicted in Figure 3, above. Water Fire is an event in which people gather to celebrate the urban renewal of Providence by lighting fires on miniature rafts that float on the canal (Nicholson, 2002). Colleges in the New England Area such as Worcester Polytechnic Institute advertise day trips for students to attend the Waterfire event in Providence.

Figure 3: Waterfire; Providence, Rhode Island (11/8/14)

Indianapolis, Indiana

Indianapolis, Indiana used a canal restoration project to connect the peaceful woods surrounding the city directly to downtown Indianapolis. The canal is lined with historic earmarks such as the crushed limestone surface of the walkway serving as a reminder of the hardworking heritage of the region. As illustrated by Figure 4, the Central Canal Towpath connects the urban environment of

Figure 4: Central Canal Towpath: Indianapolis, Indiana (Indy.gov, 2014)

Indianapolis to the surrounding forestry and the city's history by referencing historic symbols along the trail's entirety, including restored bridges (Indy.gov, 2014).

Southern United States

Texas is another state that used waterway revitalization efforts to bring economic prosperity to a region. The San Antonio River Walk in Texas focuses on preserving natural resources ("San Antonio River Walk," 2014). The revitalized waterway also became a base for tourist attractions such as restaurants, boat tours, and community events such as the annual rubber duck race in which 20,000 rubber ducks race along the restored canal ("San Antonio River Walk," 2014). San Antonio's revitalized River Walk further promotes economic and social development by drawing visitors to the now popular San Antonio Art Museum and Market Square (Smith, 1995). The surrounding area has also seen an increase in population of close to one million people (Smith, 1995).

International Revitalization Efforts

The United Kingdom has also had success with waterfront restoration projects. According to the British Waterways Authority, over 30 miles of canal have been restored in the United Kingdom, which created a successful tourist attraction in a once dilapidated area (Davis, 1997). Since the completion of the aforementioned projects in the United Kingdom in 2000, six other waterway restoration efforts have been completed in the country (Johnston, 2005). The British Waterway Authority has stated that the success of these projects is starting to be noticed (Johnston, 2005). The Authority estimates that, as of 2005, more than 2 billion British pounds have been invested in such waterway renewal projects based on the success of projects completed in the late 1990s (Johnston, 2005).

2.3 Current State of Worcester, Massachusetts

Throughout the Industrial Revolution, from 1810 – 1910, and the Great Depression, beginning in 1929, Worcester has experienced economic hardships that have contributed to some urban decay within the city.

Decline of Economic Opportunity, Deindustrialization, and Depopulation

Examining the economic opportunity, deindustrialization, and depopulation within Worcester can strongly assess the characteristics of the city. Observing Worcester's history and comparing it to statistics collected over time, residents and business owners can determine Worcester's current economic opportunity. Potential employees and future residents look at these categories in order to gauge the quality of life they can expect to experience in a city.

Based on the United States Census Bureau historical population data points, depopulation was more evident in Worcester than in Chicago as seen in Table 1 below.

Table 1: Chicago and Worcester Population Change 1840 - 1950

Historical Population				
	Chicago		Worcester	
Census	Population	% Growth	Population	% Growth
1840	4,470	-	7,497	-
1850	29,963	570.3%	17,049	127.4%
1860	112,172	274.4%	24,960	46.4%
1870	298,977	166.5%	41,105	64.7%
1880	503,185	68.3%	58,291	41.8%
1890	1,099,850	118.6%	84,655	45.2%
1900	1,698,575	54.4%	118,421	39.9%
1910	2,185,283	28.7%	145,986	23.3%
1920	2,701,705	23.6%	179,754	23.1%
1930	3,376,438	25.0	195,311	8.7%
1940	3,396,808	0.6%	193,694	-.08%
1950	3,620,962	6.6%	203,486	5.1%

Although the percentage change from the previous decades may be comparable, the acceleration of Chicago's population was tremendous due to the new economic opportunity and accessibility of transportation. Additionally, due to the increased speed of manufacturing, speed of importing resources, worker and resident densities, Chicago was accelerating much faster in economic opportunity than other areas of the United States (Galenson, 1991). Cities like

Worcester could not keep up with the manufacturing demands of the innovative world, and business owners began selling companies or abandoning them. Both Chicago and Worcester saw a decrease in population growth in 1930 due to the Great Depression (Eichengreen, 2004). Some buildings in Worcester were sold, abandoned to be maintained by the city, or left to deteriorate and decay.

Figure 5: Urban Decay in Worcester, Massachusetts (Donahue, 2009)

Figure 5, as seen above, shows a graffiti laden building in disrepair. The building has boarded up windows, is not being used, and is unable to legally support residents (Donahue, 2009). Buildings, such as the one in Figure 5, still exist throughout Worcester, and often convince urban planners that Worcester may have remnants of urban decay (Breger, 1967).

According to the United States Census Bureau, as of September 2014, Worcester, Massachusetts has a population of 182,544 people (United States Census Bureau, 2013). Observing Worcester's most recent trends in population growth seen below in Figure 6,

Worcester did have a decline in population for 30 years following peak population, in 1950. However, since 1990, Worcester's population has been increasing (Giangregorio, 2014).

Historical population		
Census	Pop.	%±
1960	186,587	−8.3%
1970	176,572	−5.4%
1980	161,799	−8.4%
1990	169,759	4.9%
2000	172,648	1.7%
2010	181,045	4.9%

Figure 6: Historical Population of Worcester (U.S. Census Bureau, 2013)

The Blackstone Canal District Alliance, of Worcester, Massachusetts, believes that a revitalization of the Blackstone Canal will help facilitate Worcester's urban renewal.

2.4 Blackstone Canal District Alliance

At the center of the Commonwealth of Massachusetts is the second largest city in the state of Massachusetts, Worcester, the heart of the Commonwealth. In an effort to return Worcester to a prospering city, area residents are working to create a tourist mecca within the city by revitalizing the Blackstone Canal. John Giangregorio, president and founder of the Blackstone Canal District Alliance, initiated a movement towards economic, social, and cultural development of the Canal District

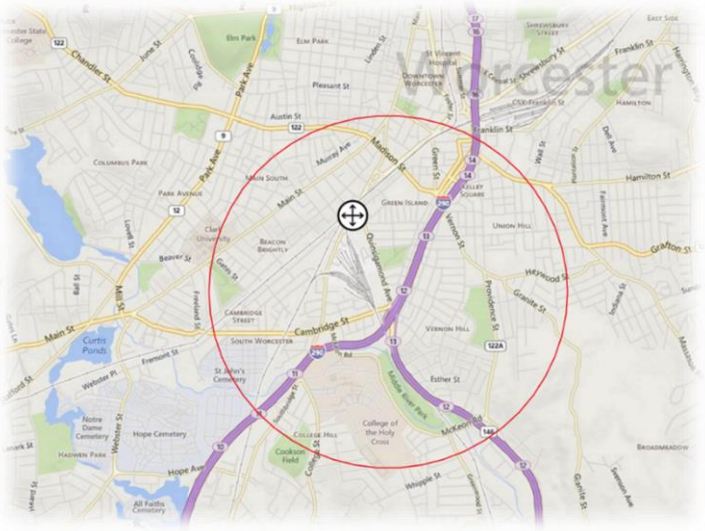


Figure 7: Canal District Map (Google Maps, 2014)

by inviting fellow Worcester residents to lunch meetings to discuss community issues (Giangregorio, 2014). These meetings expanded into the creation of the Worcester based non-profit organization known as the Blackstone Canal District Alliance (Giangregorio, 2014). The Alliance wants to promote the Canal District, which consists of the areas bounded by Mill Brook, Kelly Square, and Union Station as seen in Figure 7, above (Giangregorio, 2014). As of September 2014, meetings are held every Wednesday at 12 o'clock at the Hotel Vernon located in the Canal District. At these meetings, Alliance members and guests discuss the goals of the Blackstone Canal District Alliance. According to Giangregorio, the Alliance's vision for the Canal District is to preserve the history of the Blackstone Canal (Giangregorio, 2014).

One way the Canal District Alliance has promoted awareness of the Blackstone Canal is by hosting wagon tours of the Canal District (Duckett, 2014). These tours help to educate tourists and local residents about the history of the Canal, and the role it played in shaping the city of Worcester (Giangregorio, 2014). While these tours hold a prodigious historical value to the community, they also serve as a way for the Alliance to promote their future image for the district.

Figure 8: Canalfest; Worcester, Massachusetts (Canalfest, 2013)

The largest event the Alliance holds is Canalfest. Canalfest is an annual festival that serves as a way for the Alliance to teach Worcester residents and guests about the history of the Blackstone Canal (Eckelbecker, 2014). Canalfest started in 2004 with an attendance of over 900

attendees and has since grown to just under ten thousand in 2014 (Giangregorio, 2014). As illustrated in Figure 8, above, during Canalfest there is a recreational setup of the canal using a small pool to emulate the activities that could take place if the actual canal were restored (Blackstone Canalfest, 2013).

According to Giangregorio, the biggest accomplishment of the Alliance is the branding of the Canal District in Worcester (Giangregorio, 2014). The Alliance supports the idea of neighborhoods in Worcester being recognized formally by their historical rebranded names as opposed to their current street names (Giangregorio, 2014). The Canal District Alliance has improved the general condition of streets, sidewalks, and city infrastructure located through the Canal District of Worcester. The Canal District Alliance has made this effort in order to re-image the Canal District and to promote a sense of pride in the community (Giangregorio, 2014).

2.5. History and Current State of the Blackstone Canal

Before its termination and current state of abandon, the Blackstone Canal acted as a catalyst for economic development in Worcester and the Blackstone Valley (Reynolds, 1981). Back in the early 1800's Worcester was primarily a farming community (Cambridge University Press, 2001). Businessmen from Worcester and Rhode Island sought to create a canal that would run from Providence to Worcester to transport building supplies and textiles quickly and cheaply (Wilson, 1945).

The Canal only took four years to construct (Dickson, 1968). Benjamin Wright, the engineer behind the Erie Canal, was brought to Worcester after struggles during the first year of the Blackstone Canal's construction (Wilson, 2000). The total Canal stretched 45 miles, had vertical drop of just over 451 feet, consisted of 49 locks, and was estimated to cost $323,000 in 1825 (Wilson, 200). To give proper perspective, a cost of $323,000 in 1825 equates to

$7,690,476.19 in 2014 using the davemanuel.com inflation calculator. Between 1825 and 1835, the population of Worcester grew from 3,650 to 6,624 due to the new businesses and factories created as a result of the Blackstone Canal (Wilson, 2000).

The trip from Providence, Rhode Island to Worcester, Massachusetts took 14 hours without an overnight stop (Dickson, 1968). The Canal area transformed Worcester into a massive manufacturing city (Reynolds, 1991). Potential manufacturing led to Canal design specifications of 35 feet wide and at least 6 feet deep (Reynolds, 1991). The Blackstone Canal powered the biggest textile milling operation in New England (Reynolds, 1991).

The Canal was eventually closed in the 1890's due to the establishment of railroads in Worcester (Dickson, 1968). The same 14 hour trip could be made in 2 hours on a train. Upon completion of the railroad, the inauguration ceremony in Worcester claimed that the incorporation of the railroad would significantly boost Worcester's manufacturing and production of goods (Dickson, 1968). This proved to be correct as the construction of the railroad from Worcester to Providence greatly improved manufacturing in Worcester.

In 1997, a conference was held in Pawtucket, Rhode Island to discuss restoration of the Blackstone Canal. Bernard V. Henderson, chairman of British Waterways, who oversaw a similar canal restoration in Great Britain, said not restoring the Blackstone Canal would be a "wasted opportunity, as it is only a matter of tidying up" (Davis, 1997). As of September 2014, most of the Blackstone Canal in Worcester has been filled in and paved over by streets. Other parts of the Canal are tied into the sewer system (Baller, 2014).

2.6 Blackstone Canal Revitalization

The Blackstone Canal District Alliance wants to increase economic, social, and cultural development in Worcester (Giangregorio, 2014). In order to accomplish this, the Alliance plans to create a "multi-purpose destination neighborhood" (Giangregorio, 2014). Executive director of the Canal District Community Development Corporation, Deborah Lockwood, elaborates on the Alliance's goal: "As a part of a significant revitalization program, it is important to develop the district by identifying it as a destination -- a special place. Economic revitalization, historic preservation and environmental enhancement will be an essential component in the overall strategy" ("Blackstone Canal District," 2002). Giangregorio further explained that the Alliance wants to use the history of the Blackstone Canal as the focal point for attracting new tourists, businesses, and residents to the Canal District of Worcester (Giangregorio, 2014). In order to accomplish this, the Alliance plans to revitalize the Blackstone Canal either through a restoration or a replication (Giangregorio, 2014).

There is more than one way to revitalize the Blackstone Canal. According to Giangregorio, the options range from a full-fledged restoration and reconstruction of the Blackstone Canal to a smaller-scale replication (Giangregorio, 2014). A restoration would involve digging up the Canal that currently runs under Harding Street in Worcester ("Hope floats," 2014). A restoration would allow the actual canal to serve as the waterway that will be the centerpiece of the multi-use neighborhood the Alliance envisions (Magiera, 1999). In contrast, a replication would involve creating a new, smaller-scale waterway to serve as the focal point of the neighborhood (Magiera, 1999). Both options have advantages and disadvantages. For example, a replication of the Canal could be a less expensive option, but it might not be as

successful as a restoration when it comes to promoting the historical significance of the Blackstone Canal (Baller, 2014).

Since discussion of a Blackstone Canal revitalization started, city planners, environmentalists, conservationists, and historians have had various opinions on which option for revitalization is the best for the city of Worcester (Magiera, 1999). For example, Deborah D. Cary, executive director of the Massachusetts Audubon Society in Worcester, said that Worcester "deserves" a waterway in its downtown area and that Worcester residents should be able to view the Blackstone Canal (Magiera, 1999). Cary also feels if a restoration proves impractical, the city should look into replicating a section of the Canal (Magiera, 1999). Others, such as Ralph Spokis, spokesman for a coalition of Green Island Business owners, feel that while a canal restoration is appealing, it is definitely not feasible due to the cost and time that it would take to restore the canal to a safe, clean waterway (Magiera, 1999).

Political and Local Support

A large-scale project such as the restoration/replication of the Blackstone Canal in Worcester could benefit from political as well as local support. Massachusetts State Representative, Mary Keefe, representing the 15th Worcester district, supports the revitalization of the Blackstone Canal and believes the revitalization will stimulate Worcester's economy (Bird, 2014). In addition, the Massachusetts House of Representatives has allotted $3 million from an environmental bond bill for an engineering assessment of reopening or recreating the Canal (Duckett, 2014; Kotsopoulos, 2014). While the bill is awaiting approval from the Senate and Governor Deval Patrick, the Canal District Alliance is optimistic that the legislation will pass (Giangregorio, 2014).

In addition to political support, the Canal District Alliance and the Canal revitalization effort could benefit from support from the Worcester community (Baller, 2014). Canalfest is one way the Alliance hopes to increase local support for the Canal revitalization project (Bird, 2014; Giangregorio, 2014). The Blackstone Canalfest has successfully attracted more attendees to this festival since the first celebration in 2004 (Duckett, 2014). Giangregorio and the Alliance hope the increasing number of visitors at the Blackstone Canalfest as well as the branding of the Canal District will translate to a greater awareness and support for the Blackstone Canal revitalization project (Giangregorio, 2014; "Blackstone Canal District," 2002).

Cost and Benefit Analysis

The Blackstone Canal District Alliance believes the next step is to conduct an unbiased analysis of the costs and benefits of both a restoration and a replication of the Blackstone Canal to prove to funders and political decision makers that a Canal revitalization is a worthy investment (Giangregorio, 2014). After such an analysis, a budget and vote can commence for starting construction on the restoration/replication of the Canal (Giangregorio, 2014). Consequently, the goal of our project was to assess the costs and benefits of a Blackstone Canal revitalization for the Blackstone Canal District Alliance. Our analysis focused on whether a restoration or a replication of the Blackstone Canal could successfully enhance economic, social, and cultural development in the city of Worcester.

2.7 Analysis of Blackstone Canal Restoration/Replication

An analysis of revitalizing the Blackstone Canal including an investigation of the project's costs and benefits would help the Canal District Alliance achieve its goal of starting construction of the Canal (Giangregorio, 2014). Potential costs of restoring the Blackstone Canal include the excavation of the Canal, the demolition of existing infrastructure such as roads,

buildings, and sidewalks, the construction required to rebuild the Canal, labor costs, as well as unforeseen costs such as rerouting of underground wires, pipes, and gas lines (Hendrickson, 1998). In 2003, ICON Architecture Inc. compared the cost of a Canal restoration to similar projects which cost between $20 million and $80 million ("Canal vision," 2002). Furthermore, Duncan Hay, an urban planner for the National Park Service, predicts that this project could cost close to the same amount as a similar restoration effort in Buffalo, New York which cost $295 million (Bird, 2014).

Our assessment of the costs and benefits of a Canal revitalization may help the Canal District Alliance and the city of Worcester determine whether a restoration or replication is a better option when designing the revitalized Blackstone Canal. For our project we analyzed the costs, and benefits of a revitalization of the Blackstone Canal. We discuss our specific objectives and methodological approach in greater detail in chapter 3.

Chapter 3: Methodology

3.0 Introduction

According to Blackstone Canal District Alliance founder and president, John Giangregorio, the organization is attempting to gain political, community, and financial support for the revitalization of the Blackstone Canal in Worcester, Massachusetts (Giangregorio, 2014). The Alliance hopes to utilize the Blackstone Canal and its history to create a multi-use destination neighborhood that will serve as a catalyst for economic, social, and cultural development in the city (Giangregorio, 2014). The main goal of our project was to assess the costs and benefits of restoring and replicating the section of the Blackstone Canal which runs under Harding Street in Worcester. We discuss our specific objectives as well as the research methods we used to complete these objectives in the next several sections.

3.1 Objectives

In order to achieve our goal and objectives, we utilized various research methods including interviewing, comparative analysis, archival research, and content analysis. First, we identified relevant stakeholders for this project and the costs and benefits associated with a restoration and replication of the Blackstone Canal. Next, we compared predicted costs and benefits with the costs and benefits of similar waterway revitalization projects. Lastly, we used our findings to develop recommendations for the Blackstone Canal District Alliance on whether a restoration or replication of the Blackstone Canal will yield greater economic, social, and cultural development for the city of Worcester, Massachusetts.

Objective 1: Identify Stakeholders in a Blackstone Canal Restoration or Replication

We analyzed two options for revitalizing the Blackstone Canal in Worcester, Massachusetts, restoration and replication. A restoration would involve excavating and day-lighting the Blackstone Canal itself to serve as the main attraction for the multi-use destination neighborhood that the Blackstone Canal District Alliance envisions. A replication on the other hand would not involve unearthing the Blackstone Canal but instead would consist of constructing a new water feature on top of or to the side of the existing Canal.

In order to obtain a firmer grasp of the economic, social, cultural, and environmental costs and benefits associated with this project, our group first identified the relevant stakeholders. For the purposes of this project, a stakeholder is an individual who could potentially impact the progress of the revitalization or an individual that could provide knowledge about costs and benefits associated with the project. We worked to identify members of two groups of stakeholders who had interest in the revitalization of the Blackstone Canal: decision makers and other knowledgeable individuals. We define a *decision maker* as any individual or group that could have a say on planning, funding, or other general decision making regarding a revitalization of the Blackstone Canal. For a Canal revitalization in Worcester, decision maker stakeholders include urban planners, city officials, state representatives, and members of Congress. We identified urban planners in Worcester who could possibly be involved in designing the Blackstone Canal revitalization and city officials, state legislators, and members of Congress for the city who supported or opposed this vision.

Knowledgeable individuals include people who could help our group identify costs and benefits associated with revitalizing the Blackstone Canal. These stakeholders include historians, cultural experts, members of the Blackstone Canal District Alliance, employees at the

Department of Public Works, employees at the Department of Transportation, individuals working in economic development, and individuals working in the tourism industry. We felt these experienced individuals in Worcester, Massachusetts as well as other cities that have conducted similar waterway revitalization projects could help us identify and predict the costs and benefits of a Blackstone Canal restoration or replication from every possible angle.

In order to identify the stakeholders for a Blackstone Canal restoration or replication, our group conducted archival research to find individuals who had involvement in the proposed Canal revitalization since the vision began in the late 1990's. We also conducted content analysis of other waterway revitalization projects that have been implemented in cities across the United States. Specifically, we read articles from the Telegram and Gazette in Worcester, various articles and reports about similar waterway revitalization projects, scholarly articles, and web articles related to the Blackstone Canal revitalization in order to identify these initial stakeholders. Please see Appendix H for a list of initial interviewees we obtained through our research. As we discuss in later sections, we expanded on our content research by interviewing the list of initial stakeholders in order to gather their knowledge about the economic and social implications of a Blackstone Canal revitalization. Sample interview questions for the various stakeholders can be viewed in Appendices A, B, and C.

We took advantage of snowball sampling by using the interviews with our initial list of stakeholders to identify additional individuals or groups whose knowledge could contribute to the cost and benefit analysis of Canal revitalization. We also analyzed our data as we conducted interviews in order to identify any trends that could help us develop more specific questions to ask in other interviews. Once interviewing was completed, we compiled an expanded list of stakeholders extensive enough to help us analyze this project from an economic, social,

environmental, historical, and political level. This provided us with a good list of resources to help us complete the rest of our objectives. Please see Appendix D for the expanded list of interviewees.

Objective 2: Identify Costs and Benefits Associated with Restoration of the Blackstone Canal

For Objectives 2 and 3 we identified costs and benefits associated with the Blackstone Canal revitalization. In this section we focus on costs and benefits associated with a restoration of the Blackstone Canal. Associated costs for a restoration include costs related to the construction, demolition, labor, design and excavation of the Blackstone Canal. Once excavation begins, there may be unforeseen obstacles, and costs, including but not limited to pipes, wires, gas lines, and roadways that would need to be rerouted. Consequently, we needed to account for variability in costs associated with repairing the Canal and making it a functional water feature. In addition to identifying costs, we also identified benefits associated with a restoration of the Blackstone Canal. A restoration could potentially include economic, historic, environmental, and cultural benefits, as well as challenges. We used various research methods to identify specific costs and benefits associated with a restoration.

First, we determined that individuals with experience in the construction field and experience with a similar restoration could help us identify costs of a restoration of the Blackstone Canal. We then interviewed individuals in Worcester, Massachusetts and Providence, Rhode Island including urban planners, civil engineers, members of the Department of Public Works, members of the Department of Transportation, and professionals from construction companies. Please see Appendix A for the interview template we created for individuals to assist us in our cost estimation. We used semi-structured interviews because while we had specific

questions regarding certain costs of a restoration, we wanted these stakeholders to talk freely about any other costs that we may have overlooked.

We also interviewed people we felt could assist us in identifying benefits associated with a Blackstone Canal restoration. We talked to employees in the tourism industry, economic development professionals, members of different chambers of commerce, historians, and cultural experts in Worcester, Massachusetts; Providence, Rhode Island; San Antonio, Texas; Lowell, Massachusetts; Indianapolis, Indiana; and Buffalo, New York in order to identify benefits associated with different waterway revitalization projects as well as potential benefits for Worcester. We had either in-person interviews, telephone conversations, or email correspondence with these individuals.

We also researched literature and economic impact reports that identified costs and benefits of similar waterway restoration projects. We analyzed projects that have focused on promoting economic development through the construction of a waterway. The specific list of projects we analyzed in the United States included the Capital Center Project in Providence, Rhode Island; the in-progress Canalside project in Buffalo, New York; the Canalway and Riverwalk in Lowell, Massachusetts; the Canal Walk project in Indianapolis, Indiana; and the River Walk project in San Antonio, Texas.

Objective 3: Identify Costs and Benefits Associated with Replication of the Blackstone Canal

Our group also investigated a replication of the Blackstone Canal as a potential economic development strategy. To do this we analyzed the option of replicating the Blackstone Canal and the costs and benefits associated with a replication. The methods we used to complete this objective were similar to those used to identify the costs and benefits associated with restoring the Blackstone Canal.

Again, we interviewed many of the same urban planners, civil engineers, members of the Department of Transportation, members of the Department of Public Works in Worcester in order to determine the costs associated with a replication of the Blackstone Canal. We sought educated opinions and advice from these individuals whose experience could help us identify costs and benefits associated with a replication of the Blackstone Canal.

In addition to interviewing individuals in Worcester, we researched the Bricktown Canal project in Oklahoma City, Oklahoma. We interviewed members of the planning department, economic development office, and employees in the city's tourism industry in Oklahoma City in order to obtain information on the costs and benefits associated with the Bricktown Canal project. We also analyzed economic impact reports and web articles in Oklahoma City to conduct content research on associated costs and benefits.

Objective 4: Analyze Potential Costs and Benefits Related to a Blackstone Canal Revitalization in Worcester

Once Objectives 2 and 3 were completed, we analyzed the costs and benefits of a Blackstone Canal revitalization. We comparatively analyzed similar revitalization projects and conducted interviews with various professionals in both Worcester and other cities in order to complete this objective.

First, we searched for cost and benefit data from similar revitalization projects that we could compare to the potential Blackstone Canal revitalization. We analyzed the size and scope of similar projects in Providence, Rhode Island; San Antonio, Texas; Lowell, Massachusetts; Oklahoma City, Oklahoma; Indianapolis, Indiana; and Buffalo, New York in order to determine if the various costs associated with these projects could be compared to a Blackstone Canal restoration or replication. We then compared cultural, social, historic, and economic benefits of

these projects to the potential Canal revitalization. We also analyzed the aforementioned projects in order to weigh their benefits against the costs. Using the information we gathered from other projects, we attempted to determine if the various benefits of either a Blackstone Canal restoration or replication would successfully bring economic, social, historic, and cultural development to the Canal District in Worcester as well as the city as a whole.

We held interviews with urban planners, members of chambers of commerce, individuals from travel and tourism organizations, state representatives, and city officials in Worcester, Massachusetts, as well as cities that have completed similar projects. Talking to Worcester professionals gave us strategies on how to predict costs and benefits while interviewing individuals in other cities gave us costs and benefits to compare the predictions to. We spoke with experts in Worcester from the Department of Public Works, National Park Service, Economic Development Office, Assessing Office, and the Chamber of Commerce in order to analyze the costs and benefits associated with a Blackstone Canal revitalization. We also talked to professionals in the same sectors in other cities that have conducted similar waterway revitalization projects in order to obtain information not available through archival research.

Objective 5: Develop Recommendations for the More Beneficial Revitalization Effort

In order to complete the last objective and achieve the goal of our project, we used the information gathered through completion of objectives 1-4 to develop our recommendations for the Blackstone Canal District Alliance. That is, we resolved if either a restoration or a replication of the Blackstone Canal would be the more appropriate choice considering the economic, social, and historical implications for the city of Worcester. We analyzed the costs and benefits of a Blackstone Canal restoration and replication and compared the feasibility of both options. We

then communicated our findings and recommendations with the Blackstone Canal District Alliance.

3.2 Obstacles in Collecting Data

While collecting this data, the main obstacle we faced was obtaining economic impact before and after data from the similar waterway revitalization projects we analyzed. The Bricktown Canal in Oklahoma City and the River Walk in San Antonio were the only two projects that had economic impact reports directly related to the waterway revitalization projects. For the other cities we had to rely on qualitative data from interviews or the current economic activity surrounding the waterways.

Additionally, when conducting interviews with different types of persons such as politicians, urban planners, and other professionals we dealt with many scheduling issues. Some individuals we intended to interview were not available to speak with our project group. Furthermore, many individuals we interviewed did not have access to the various data we were requesting.

We detail the findings and recommendations in the next chapter.

Chapter 4: Findings and Recommendations

In this chapter we begin with a comparison of the proposed Blackstone Canal revitalization project with similar projects that have been conducted in the United States. Specifically, we analyze tourism, potential economic investment, quality of life, and aesthetic appeal improvements as a result of these projects. Next we explore the unique challenges posed by the fact that the Mill Brook section of the Blackstone Canal, the focus of this project, is currently being used as a Combined Sewer Overflow reservoir. Towards the end of this chapter we assess whether replication of the Blackstone Canal is more feasible than restoration of the Canal. Finally, this chapter concludes with our recommendations for how the Blackstone Canal District Alliance might proceed with their revitalization efforts.

I. Comparison to similar waterway revitalization projects

Waterway revitalization efforts in Providence, Rhode Island; Oklahoma City, Oklahoma; Indianapolis, Indiana; San Antonio, Texas; Lowell, Massachusetts; and Buffalo, New York show the potential impact a Blackstone Canal revitalization can have in Worcester, Massachusetts. Our group researched several cities that have conducted waterway revitalization or construction projects. The projects include: Waterplace Park in Providence, Rhode Island; the Bricktown Canal in Oklahoma City, Oklahoma; the Canal Walk in Indianapolis, Indiana; the River Walk in San Antonio, Texas; the Canalway and Riverwalk in Lowell, Massachusetts; and the Canalside in Buffalo, New York. While the projects varied in scope of economic impact, all were useful in assessing the potential economic, historic, and social impacts in Worcester.

Before we elaborate on the comparative data we found, we first want to introduce the various sizes and costs of the aforementioned waterway revitalization and construction projects.

First, all of the projects involved the restoration or unearthing of a pre-existing waterway except the Bricktown Canal in Oklahoma City, which consisted of the construction of a new waterway. Furthermore, Waterplace Park in Providence and the Bricktown Canal in Oklahoma City were part of more extensive urban renewal projects. Providence's Capital Center, which cost a total of $425 million ("Free the Blackstone," 2003), consisted of 11 development projects including the relocation of railroads, rerouting of interstate ramps, rerouting of roads, and the creation of new parks and open spaces (Farbstein, 2004). The Bricktown Canal, which cost $26.1 million, was one of nine urban renewal projects in the Metropolitan Areas Projects which in total cost $350 million (Carpenter, 2014). Additionally, the five mile River Walk in San Antonio, the nearly six miles of waterways in Lowell, and the 21-acre Canalside park in Buffalo are all larger than the proposed half-mile Blackstone Canal in Worcester. We considered the different sizes and costs of these similar projects when we analyzed the various benefits associated with a Blackstone Canal revitalization. The various sizes and costs of similar waterway revitalization projects can

Table 2: Size and Cost of Similar Waterway Revitalization Projects

Location	Project	Length of Waterway (miles)	Cost ($)
Buffalo, NY	Canalside	not available	48,000,000
Indianapolis, IN	Canal Walk	3	not available
Lowell, MA	Canalway and Riverwalk	3.5	52,400,000
Oklahoma City, OK	Bricktown Canal	1	26,100,000
Providence, RI	Waterplace Park	1	130,000,000
San Antonio, TX	River Walk	5	368,300,000

be seen in Table 2, above. We analyze tourism, private investment, quality of life, increased aesthetic appeal, and events at each of these revitalized waterways and of these projects and the potential impact Worcester could expect to experience in sections a. through e., below.

a. Increased tourism

Increased tourism due to similar waterway revitalization projects shows the potential economic impact a Blackstone Canal revitalization could have in Worcester. Through content analysis and contact with professionals from tourism bureaus and organizations, we analyzed tourism data from comparable waterway revitalization projects exploring whether the waterway project caused or contributed to increases in tourism. One study conducted by Steve Nivin, Ph.D in economics, titled, "Impact of the San Antonio's River Walk," contained quantitative data on the economic impact that increased tourism as a result of the River Walk brought to San Antonio (Nivin, 2014). The study indicated that approximately 11.5 million visitors were attracted specifically to the River Walk in a 12 month period between 2012 and 2013 (Nivin, 2014). These visitors also spent approximately $2 billion on leisure activities around the River Walk in this year-long period (Nivin, 2014). The breakdown of these expenditures can be seen in Table 3, below. Comparing this data to potential tourism in Worcester would be difficult as the $358 million River Walk consists of 5 miles of walkways and parks along the waterway compared to the proposed half-mile Blackstone Canal in Worcester. However, this study done by Nivin exhibited considerable patronage and substantial tourism expenditures in San Antonio as a direct result of a waterway revitalization project.

Table 3: San Antonio River Walk Tourism Expenditures 2012-2013 (Nivin, 2014)

Sector	Expenditures	Percentage
Restaurants/Bars	$684,056,576	33.7%
Entertainment/Recreation	$519,164,553	25.6%
Hotels	$447,706,708	22.1%
Shopping	$369,056,401	18.2%
Other	$7,564,846	0.4%
Total	$2,027,549,084	100.0%

Furthermore, interviews with tourism and economic development professionals in similar cities indicated the importance of the various waterway revitalization efforts on attracting more tourists. While Martha Sheridan from the Providence Warwick Convention and Visitors Bureau and Eric Long from the Oklahoma City Chamber of Commerce could not reference specific tourism studies, they were able to attest to strong increases in tourism related to their respective waterway revitalizations. Sheridan in particular compared hotel occupancy before and after the mid-1990's completion of the Capital Center project. She stated that the completion of the Capital Center project, which includes Waterplace Park, catalyzed the transformation of Providence from a strictly business destination to a tourist destination. This statement is supported by changes in Providence hotel occupancy from Monday through Wednesday pre-project to Saturdays post-completion. Lastly, Sheridan was able to show hotel occupancy data which indicated average occupancy of over 90% on almost every Saturday in the months of June, July, August, and September of 2014 compared to averages ranging from 78%

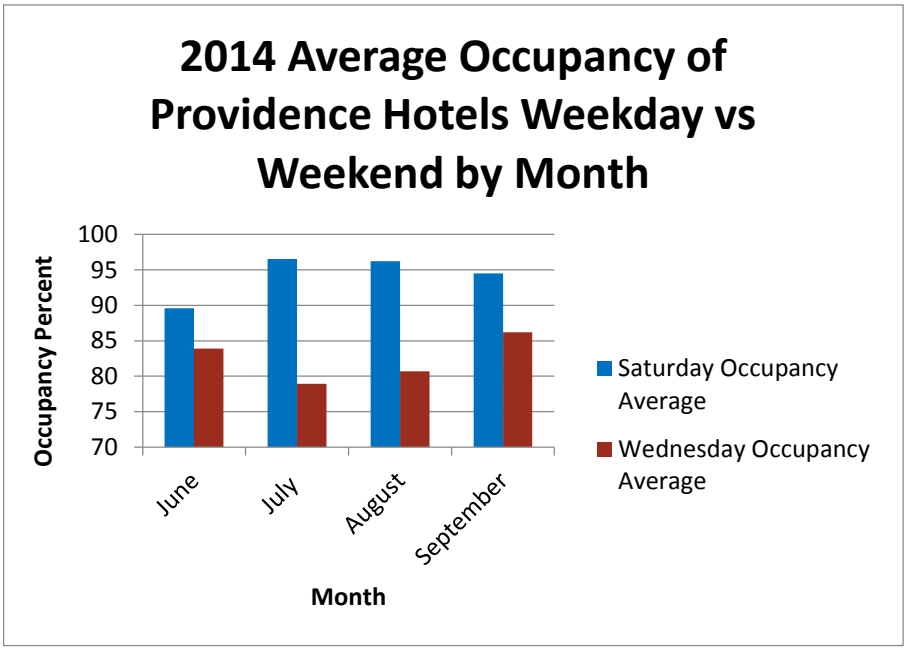


Figure 9: 2014 Wednesday vs Saturday Hotel Occupancy Providence, Rhode Island (STR Inc., 2014)

to 86% occupancy in the middle of the week (STR Inc., 2014). This data is illustrated in Figure 9, above.

We also explored tourism impact in Oklahoma City by analyzing relevant data. The most popular attraction at the Bricktown Canal is the Water Taxi boat tours along the Canal, shown in Figure 10, right. A 2009 study conducted for the Oklahoma City Chamber of Commerce Larkin Warner, Ph.D in economics, reported that over 100,000 tourists visited the Water Taxi tours every year from 2003 to 2008 and paid approximately ten dollars for an all-day pass (Warner, 2009). Again, this data shows the potential for increased tourism and tourism expenditures in relation to a waterway revitalization. The data, expressed in Table 4, below, shows the number of attendees increased from 2003-2005 and then leveled off until 2008.

Figure 10: Water Taxi boat tour: Oklahoma City Oklahoma (oklahomablogger.com)

Table 4: Water Taxi Visits, Bricktown Canal, Oklahoma City (Warner, 2009)

Year	2003	2004	2005	2006	2007	2008
Water Taxi Visits	103,500	110,400	139,200	139,200	139,200	141,700

While we are unable to predict precise number of visitors resulting from a revitalization, *comparing the Blackstone Canal to a venue in Worcester showed the potential tourist draw a revitalized waterway would potentially see.* In order to generally analyze the number of visitors a Blackstone Canal revitalization in Worcester could expect to see, we researched tourism statistics for the Hanover Theatre in Worcester. Peter Dunn from the Economic Development

Office in Worcester presented a study in the Worcester Business Journal which noted in 2013 the Hanover Theatre had 211,517 visitors (WBJournal, 2014). With the help of Dunn, we analyzed this venue for different reasons. First, both the Hanover Theatre and the proposed Canal are located in Worcester. Therefore, a Blackstone Canal revitalization would expect most of its visitors to come from the same surrounding area. Visitors to the Canal, like the Hanover Theatre, would consist mostly of residents within a 50 mile radius as well as Worcester residents. Second, the Hanover Theatre holds events that promote culture and history which would also be the focus of a Blackstone Canal revitalization. There are also differences between both attractions. The Hanover Theatre is able to hold events throughout the entire year. While visitors to the Blackstone Canal could potentially use the water for ice skating or sled rides, the Canal would be limited to the amount of events and programming it could have in the winter months. Furthermore, a Blackstone Canal would be a passive pedestrian attraction that would draw visitors throughout the entire day whereas the Hanover Theatre primarily holds events at night. While the Hanover Theatre and the proposed Blackstone Canal are different attractions, similarities between the two can give an idea on the nature of visitation a Blackstone Canal might experience.

b. Domino effect of further private investment, increased property values and tax revenue

Further private investment following the completion of similar waterway revitalization projects shows the potential economic impact a Blackstone Canal revitalization could have in Worcester. The revitalization and construction of similar waterways attracted potential investors and developers to come in and restore and reutilize old buildings or create new construction projects. Martha Sheridan, of the Providence Warwick Convention and Visitors Bureau, stated that Providence's Capital Center, which includes Waterplace Park, has become a focal-point for

further developments in the city (Sheridan, 2014). Some of these major developments include "Providence Place Mall, the Rhode Island Convention Center, the Westin and Marriot Courtyard Hotel, the restoration of the historic Union Station complex, a luxury residential complex, the headquarters of the Citizens Financial Group and the regional headquarters for American Express" (Marsella Development, n.d.). Some of these developments can be seen in Figure 11, below.

Figure 11: Map of Area Surrounding Waterplace Park, Providence, Rhode Island (www.chs54.org, n.d.)

Similarly, according to Jim Cowan, Director of the Bricktown Association, as of 2009 approximately $109 million in private real estate development has been completed along the Bricktown Canal in Oklahoma City (Lackmeyer, 2009). Cowan also included an additional $31 million in developments such as the Bricktown Hampton Inn, the American Banjo Museum, and several other projects not located directly along the Canal. These additional investments increased the total private real estate development resulting from the Bricktown Canal to $140 million which was the amount of development that was predicted for all nine of the Metropolitan

Area Projects (Lackmeyer, 2009). Total private development investment in Oklahoma City and Providence are shown in Table 5, below, along with the investments related to projects in Buffalo, Lowell, and San Antonio.

Table 5: Private Investment in Similar Cities

Project	Private Investment
Capital Center, Providence	$1.2 billion (as of 2014)
Bricktown Canal, Oklahoma City	$109 million (as of 2009)
Canalside, Buffalo	$305 million (as of 2014)
Canalway Riverwalk, Lowell	$527 million (as of 2011)
River Walk, San Antonio	$253 million (as of 2009)

Increased property values and property tax revenue in similar cities show the potential impact in Worcester. A 2009 study conducted for the Oklahoma City Chamber of Commerce by Larkin Warner, Ph.D in economics, analyzed increased property values along the Bricktown Canal. Warner referenced another study that assessed 23 commercial properties in the Bricktown District of Oklahoma City. This assessment showed a 337% increase in these property values between when the Canal was completed in 1999 ($10.8 million) and 2004 ($36.3 million) (Warner, 2009). A linear relationship would also be seen in increased property tax revenue to the city. Warner stated how Oklahoma City's real estate market value increased 60.2% compared to 42.8% in the rest of Oklahoma County in this time period. The total assessed property values for the 23 assessed commercial properties can be seen in Table 6, below. While other factors could have led to these increased property values, Warner's study suggested that the Bricktown Canal and the rest of the Metropolitan Area Projects increased the appeal of properties in the Bricktown District to investors and developers. Furthermore, it is important to note that the study analyzed the impact of all the Metropolitan Area Projects, not just the Bricktown Canal. Still, this study

Table 6: Assessed Value of 23 Commercial Properties in Bricktown: Oklahoma City, Oklahoma 1999, 2004, 2008 (Warner, 2009)

	Market Value, 1999	Market Value, 2004	Market Value, 2008	Change in Market Value, 1999-2004	Change in Market Value, 1999-2008	Percent Increase, 1999-2004	Percent Increase, 1999-2008
Assessed Commercial Properties	$10,762,060	$36,283,240	$41,378,096	$25,521,180	$30,616,036	337%	384%

shows how a revitalized waterway could potentially contribute to increased property values and property tax revenue in Worcester.

Buildings along Harding Street in Worcester would benefit from potential private investment as a result of a revitalized Blackstone Canal. As of December 2014, Harding Street in Worcester had six buildings along its half-mile length that were vacant according to a list of assessed values provided by Peter Dunn of Worcester's Economic Development Office and City Assessor William Ford. Upon observation, we determined that several non-vacant buildings on Harding Street could also benefit from renovations and investment from investors or developers. Figure 12, above, shows buildings along Harding Street that could potentially benefit from increased private real estate investment. Shown below in Table 7 are the total property values and property tax revenue, broken down by category, for properties listed on Harding Street, Temple Street, Winter Street, and Pond Street as of December 2014.

Figure 12: Buildings Along Harding Street in Need of Renovation (photo taken 11/1/14)

Table 7: Assessed Value of 23 Commercial Properties in Bricktown: Oklahoma City, Oklahoma 1999, 2004, 2008 (Warner, 2009)

Property Type	Commercial	Residential	Non-Profit	Vacant
Total Assessed Value, 2014	$8,679,300	4,895,400	2,889,100	933,600
Property Tax per $1,000 Assessed Value	$30.83	$19.54	N/A	N/A
Property Tax Revenue for Worcester	$267,582,819	$95,656	N/A	N/A

Worcester City Assessor, William Ford, could not provide any evidence that a water feature alone would increase the above property values. Instead, Ford felt it would be more plausible to say that the appeal of property along a revitalized Blackstone Canal would lead to private investment that would in turn increase property values and property tax revenue to the city.

c. Quality of life

Similar waterway revitalization projects show the potential for increased quality of life for residents and visitors of Worcester. By increased quality of life we are referring to the increased enjoyment residents in the area can expect to experience as a result of a Blackstone Canal revitalization. Quality of life improvements were a recurring theme in cities that had undertaken waterway revitalization/construction projects. According to a study completed by Steve Nivin, Ph.D in economics, on the impact of the San Antonio River Walk, the River Walk is a mix of restaurants, shops, entertainment venues, businesses, museums, historical sites, and recreation areas (Nivin, 2014). The River Walk has contributed greatly to the quality of life of San Antonio residents by creating a destination residents can visit and enjoy on any given day (Nivin, 2014). In Figure 13, below, you can see the result of surveys completed by 186 residents of Bexar County, Texas, where the San Antonio River Walk is located, and their reasons for visiting the River Walk.

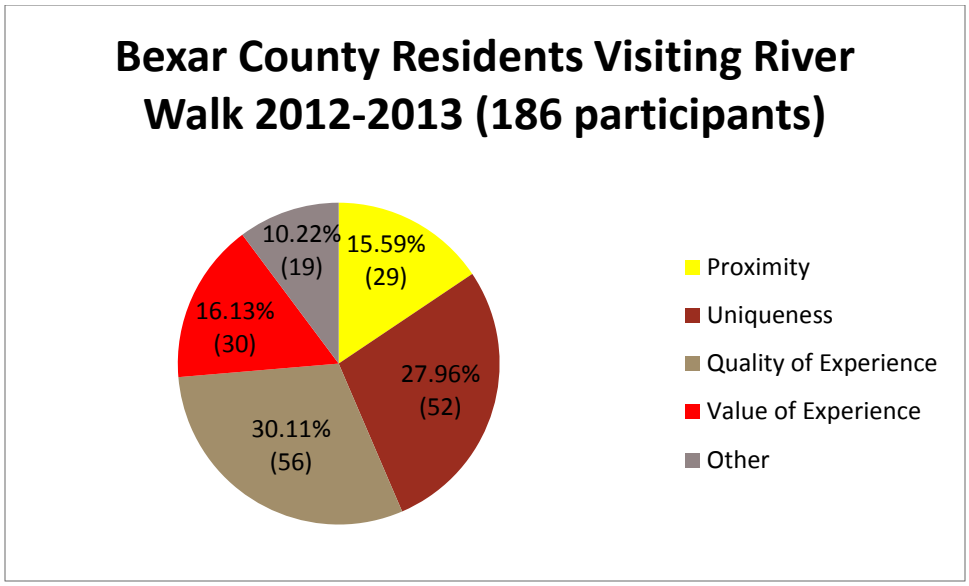


Figure 13: Bexar County Residents Visiting River Walk (Nivin, 2014)

Out of 186 people surveyed from Bexar County, 30% said they came for the quality of the experience and 16% said they came for the value of the experience. From this we concluded that just over 45% of the Bexar County residents surveyed went to the River Walk because they thought they would enjoy it. Furthermore, 28% of people surveyed said they went to River Walk for the uniqueness of the experience, and 16% went to River Walk because it was close to home. If you take the entire survey as a whole 167 people or 89.78% came to the area of the water feature for some sort of experience that would enhance their quality of life.

According to Martha Sheridan, CEO of the Providence Warwick Convention and Visitors Bureau, Providence, Rhode Island saw the development of retail venues and restaurants after the completion of the water feature. The increase in places for leisure activity, most notably the Providence Place Mall, coupled with the aesthetics of the newly constructed Waterplace Park enhanced the quality of life not only for the residents of Providence, Rhode Island but anyone who chose to visit the area (Sheridan, 2014). Waterplace Park provides residents, visitors, and

workers in Providence with a passive pedestrian attraction in the middle of an urban area (Sheridan, 2014).

Chuck Arning from the National Park Service, Susan Ceccacci from Preservation Worcester, Jeannie Hebert from the Blackstone Valley Chamber of Commerce, and John Giangregorio of the Blackstone Canal District Alliance believe a Blackstone Canal revitalization would bring quality of life benefits to Worcester residents, visitors, and employees who work in the city. These experienced individuals felt a Canal along Harding Street in Worcester would give residents a safe and enjoyable leisure destination.

d. Increased aesthetic appeal

Similar waterway revitalization and construction projects show the potential increase in aesthetic appeal for Harding Street in Worcester. Waterway revitalization efforts would increase the visual appeal of blighted urban areas in particular. Oklahoma City's Bricktown Canal, for example, helped transform and revive the Bricktown area into a "vibrant community center" (Carpenter, 2014). Buildings and other infrastructure in the Bricktown area of Oklahoma City experienced the adverse effects of the collapse of Oklahoma's oil boom in the 1980's (Warner, 2009). While the Bricktown Canal was just one of the nine Metropolitan Area Projects completed in Oklahoma City in the late 1990's and early 2000's, it has contributed to the aesthetic transformation of the Bricktown area in particular. Figures 14 and 15 illustrate the aesthetic result of the Bricktown Canal project on one of the replaced streets. The before picture depicts a street in need of paving, underutilized buildings, and an overall lifeless urban area. The after picture shows an active, multi-use destination neighborhood.

Figure 14: Bricktown Canal Before (Carpenter, 2014)

Figure 15: Bricktown Canal After (Carpenter, 2014)

Harding Street in Worcester, Massachusetts has several blighted areas that could benefit from the increased visual appeal of a revitalized Blackstone Canal. At least six of the buildings along Harding Street are vacant and several more are visually run-down, as shown in Figure 16, below.

Figure 16: Blighted Building on Harding Street (Photo taken 11/1/14)

As discussed in section b., above, a revitalized Blackstone Canal would increase the appeal of these properties to potential investors looking to restore and utilize the various buildings. This claim is supported by the private investment experienced in other cities that have revitalized or constructed new waterways, as also discussed in section b. This private investment would increase the aesthetic appeal of buildings along Harding Street. Figures 17 and 18, below, show the aesthetic appeal associated with the Canal Walk in Indianapolis and the River Walk in San Antonio.

Figure 17: Canal Walk: Indianapolis, Indiana (visitindy.org)

Figure 18: River Walk: San Antonio, Texas (thesanantonioriverwalk.com)

e. Events and programming along the waterway

Similar waterway revitalization projects use events and programming along their waterways to help catalyze economic activity in the surrounding area. While specific tourism numbers are difficult to predict, a popular trend in similar cities was the importance of events and/or programming along the waterway to maximize the potential economic activity. Furthermore, Martha Sheridan, President and CEO of the Providence Warwick Convention and Visitors Bureau, and Peter Dunn, Economic Development Office of Worcester, both expressed the necessity of an event schedule as well as a position or organization to maintain that schedule in order to guarantee the success of the waterway.

Waterplace Park of Providence draws many visitors with its WaterFire event that is held multiple times throughout the spring, summer, and fall months. Providence also has a Convention and Visitors Bureau to help monitor and plan this event as well as other public events along the water. After visiting Waterplace Park on both a normal business day and a WaterFire event, we were able to see the dramatic difference in visitors to the waterway. Figures 19 and 20 below shows differences in the number of visitors on a night of WaterFire compared to a Monday afternoon.

Figure 19: WaterFire Festival: Providence, Rhode Island (Photo taken 11/8/2014)

Figure 20: Waterplace Park: Providence, Rhode Island (Photo taken 11/3/14)

Oklahoma City is another city that uses programming along its waterway to promote economic activity. As mentioned above in section I, the Bricktown Canal has Water Taxi boat tours that attracted over 100,000 visitors every year from 2003 to 2008 (Warner, 2009). These visitation statistics show how programming helped maximize tourist activity along a waterway.

Figure 21, below, expresses the reasons residents of Bexar County, Texas, gave for

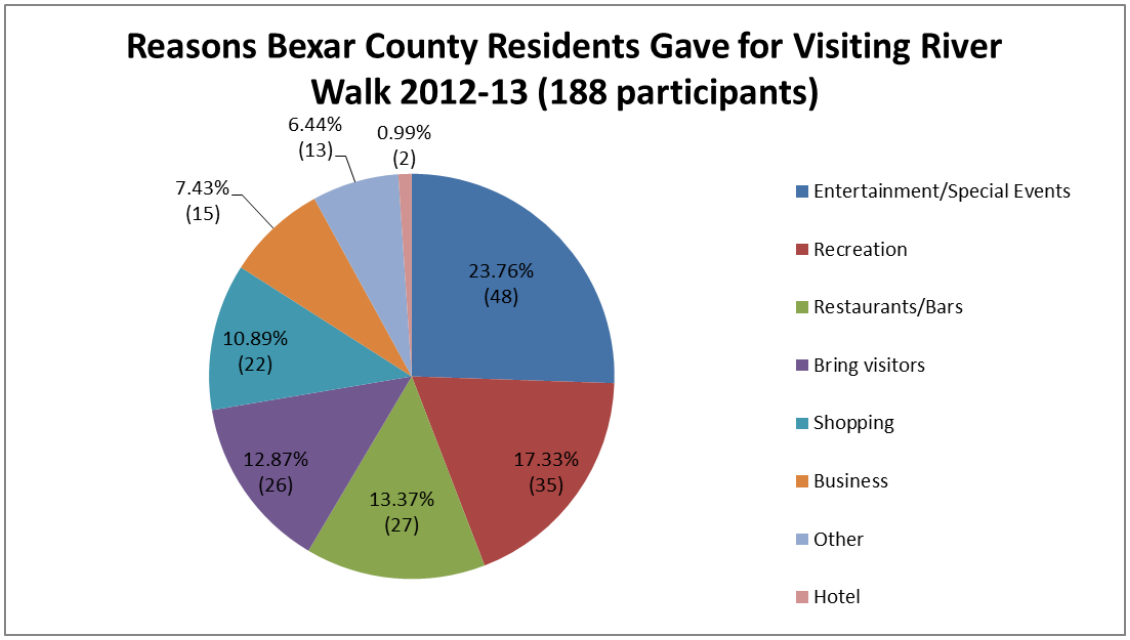


Figure 21: Reasons for visiting River Walk, San Antonio, Texas (Nivin, 2014)

visiting River Walk in San Antonio. Approximately 24% of the 188 county residents surveyed said that they visited River Walk for entertainment or special events. This study, conducted by

Steven Nivin, Ph.D in economics, illustrates how another city uses events along its waterway to attract visitors.

The reccurring theme among the similar cities we analyzed was that events are important to maximizing the potential of a revitalized waterway. John Giangregorio and other members of the Blackstone Canal District Alliance gave several examples of events and programs that already operate in the Canal District. These events include Canalfest, Canaloween, a Santa Claus Pub Crawl, a Mardi Gras event, and summer wagon tours. Based on the success similar cities have had with events along their waterways, events along a revitalized Blackstone Canal would help maximize the amount of visitors to the Canal.

II. Blackstone Canal restoration versus replication

Before we analyze the differences between a restoration and replication of the Blackstone Canal in Worcester, it is important to discuss the state of the Blackstone Canal and how the city of Worcester utilizes the waterway. After we identified how the use of the Canal, we compared the associated costs and benefits of both a restoration and a replication of the Blackstone Canal. This comparison allowed us to determine which option would be more beneficial for the city of Worcester.

a. State of the Canal, Combined Sewer Overflow (CSO) system

The section of the Blackstone Canal under Harding Street is an integral part of Worcester's Combined Sewer Overflow (CSO) system. Department of Public Works professionals: Paul Moosey, Commissioner; Al Charbonneau, former Sewer Pumps Station Supervisor; and James Okerberg, Assistant Chief Pumping Station Operator, collectively explained how Worcester utilizes the Blackstone Canal under Harding Street as a storage tank to

assist the water treatment process during increased storm water collection. This system is known as a Combined Sewer Overflow system, or CSO. A Combined Sewer Overflow system is a single "pipe" that collects rainwater runoff, domestic sewage, and industrial wastewater (Environmental Protection Agency, 2014). In order to visualize where the CSO system runs, Christopher Gagne, a Civil Engineer with the Worcester Department of Public Works provided our group with the Geographic Information System (GIS) diagram of the Harding Street area. The combined sewage as well as other utility pipes can be seen in the diagram in Appendix F.

The utilization of the Blackstone Canal as a storage tank assists the wastewater treatment plant on Quinsigamond Avenue in Worcester in processing and treating combined sewage and storm water. Al Charbonneau and James Okerberg explained the importance of the Canal in terms of the Combined Sewer Overflow system. Charbonneau and Okerberg provided our group with a document, seen in Appendix G, which shows the 32 pumping stations located throughout Worcester and the amount of water they treat or process. Of the 32 pump stations, the Quinsigamond Avenue water treatment facility is the only treatment facility that handles the Combined Sewer Overflow water that comes from the Blackstone Canal reservoir underneath Harding Street. The portion of the Canal under Harding Street holds up to 150 million gallons of combined sewage and stormswater. The Quinsigamond Avenue water treatment facility processes 200,000 gallons of sewage per day during dry weather flow periods. During a storm, the Canal is able to hold excess water which gives the water treatment facility the ability to control how much water flows into the plant.

The water treatment facility uses a leaf gate, which can be raised and lowered, in order to control how much water can be released from the Canal reservoir and flow to the water treatment facility. This allows the water treatment facility to more efficiently process the water and create

higher quality water leaving the plant and entering the Blackstone River. Controlling the amount of water flowing from the Canal also prevents the water treatment facility from having to bypass raw sewage and storm water straight into the Blackstone River. The process of how the city of Worcester utilizes the Blackstone Canal as a Combined Sewer Overflow storage tank is outlined in a flow chart seen below in Figure 22.

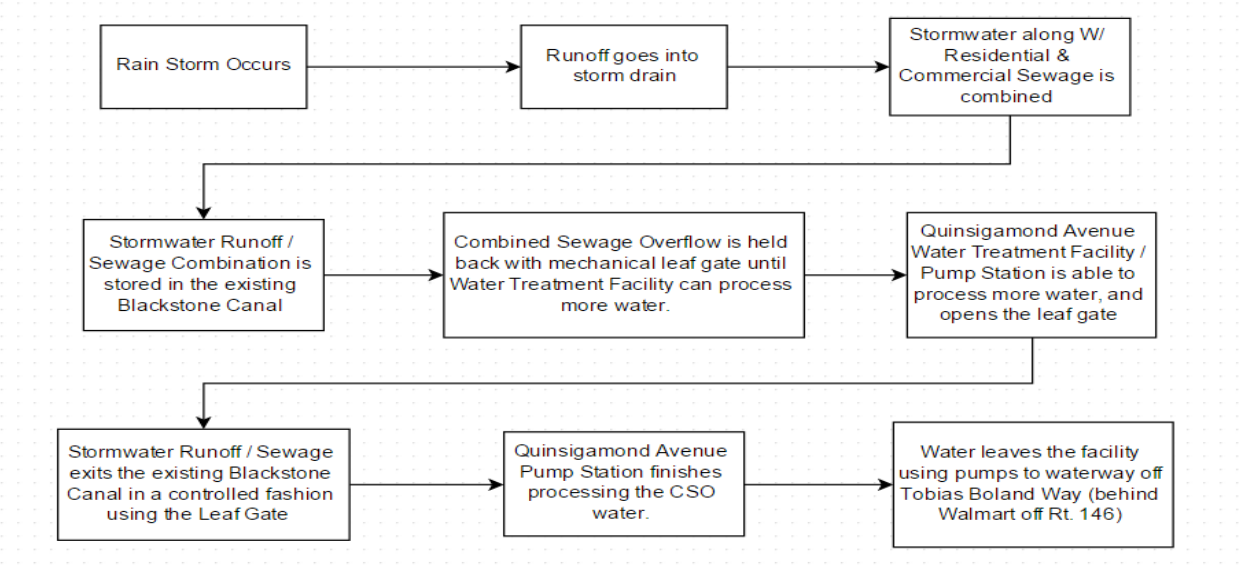


Figure 22: Flow chart Combined Sewer Overflow treatment process

A replication of the Blackstone Canal would allow for the city of Worcester to continue to utilize the Blackstone Canal as a CSO reservoir. Based on the above information received from the Department of Public Works, the Canal helps the city of Worcester meet the United States Environmental Protection Agency standards for surface water discharges. A new storage tank would need to be constructed alongside the existing Canal if the CSO reservoir was eliminated. This construction would substantially increase the cost of a Canal revitalization as we discuss in the following section.

b. Restoration Costs

Rerouting of the Combined Sewer Overflow system would significantly increase the cost of restoring the Blackstone Canal. Paul Moosey, Commissioner of the Department of Public Works, explained that a restoration would be significantly more difficult to implement than a replication. When taking into consideration the complexity of the CSO, and considering the structural integrity of the existing Canal once uncapped and unearthed, Paul Moosey explained that the costs of implementing a restoration, and a new CSO system, would be on the magnitude of hundreds of millions of dollars. If the CSO were not an issue, then he explained that a restoration may be equivalent or actually less expensive than a replication. Between saving money in excavation and concrete costs and applying it towards the cleansing of the bricks and supporting the existing structure, the costs would be very comparable to the replication costs. Considering Worcester's existing funds, and the functional practicality of the Canal as a CSO for the city of Worcester, he does not believe the restoration option is feasible enough for a proper restoration assessment to be worthwhile. We were better able to estimate exact costs of a replication of the Canal, as explained in the next section.

c. Replication Costs

Using seven different estimation strategies we found an average cost of a Blackstone Canal replication to be approximately $20,500,000. In this section we discuss the seven different strategies we used to estimate the cost of replicating the Blackstone Canal on Harding Street. We also give the range and median value for our estimations.

1) Modern Day Bid Pricing of a Blackstone Canal Replication

In the following paragraphs, we use a method for assessing costs which we refer to as "modern day bid pricing." We first observed itemized quantities from the 2003 feasibility assessment "Free the Blackstone" by Rizzo Associates, ICON Architecture, and the Williams Group. We then compared cost categories from this study to 2014 construction project bid prices. Considering advancements in transportation, manufacturing, and material science, modern construction bid pricing yields a more accurate cost estimate than strictly applying an inflation factor. Most companies had different prices for each cost category based upon their company connections. To account for this, we took a mean and median from the set of values for each cost category which we refer to as either the mean or median weighted average bid price. Updated mean and median bid pricing, by itemized quantities, from the 2003 feasibility assessment can be seen in the last two columns of Appendix G. Furthermore, mean and median weighted bid costs can be seen throughout the following seven assessments in Table 8 below.

2) Inflation Calculator

Additionally, existing streetscape along Harding Street would need to be replaced and updated. Streetscape costs consider the following elements: sidewalks, street furniture, trees, trashcans, bike racks, lawns, ground cover, shrub plantings, banners, street lamps, street signs, and any additional components pertaining to the specific project, typically listed as miscellaneous ("Free the Blackstone," 2003). The 2003 feasibility assessment from Rizzo Associates and ICON Architecture, located out of Boston, Massachusetts, established a rough estimation on replacing the streetscape on Harding Street, in the Canal District, at $0.6 million. After taking into consideration a standard inflation calculator applied to the rough estimate, the cost of implementing a new streetscape on Harding Street would be approximately $776,188

(Bureau of Labor Statistics, 2014). We also estimated this number in a different way by using modern streetscape weighted average bid pricing. We estimated the costs to be approximately $1.9 million dollars which would include the following: curb-trees, lighting, interpretive exhibits, lawns, benches, trash bins, and miscellaneous expenses.

3) Department of Public Works Recommendations and Estimations

Our first two approaches towards obtaining an accurate modern assessment for the costs associated with a replicated Canal involved contacting the Worcester Department of Public Works. Paul Moosey, Commissioner and 20-year veteran of the Worcester DPW, strongly recommended the Alliance focus on a replication of the Blackstone Canal along Harding Street in the Canal District, finding replication to be more feasible than a restoration of the existing canal. Paul Moosey described a replicated Canal design as an inverted culvert. Approximate dimensions for our estimation would be 38 feet in width, and 3 feet deep. Moosey roughly estimated $2,000 - $3,000 per linear foot of concrete to make up the culvert. We determined the length of Harding Street, from Franklin Street to Kelley Square, to be approximately 0.5 miles or 2,640 feet. The cost of concrete at $3,000 per linear foot (high estimation) is calculated to be approximately $7,920,000. Following Paul Moosey's recommendations of implementing a 15% cushion, followed by a 15% construction contingency, and a 10% utility contingency, the total cost is approximately $11,500,000. All of these percentages were applied to obtain rough estimations for this type of construction project. Applying the cushion would allow for potential unexpected obstacles to be funded ahead of time. This would be the total amount for just the waterway with the appropriate contingencies. The streetscape, including landscaping, sidewalks, benches and additional features, still needs to be added onto this approximation. Paul Moosey's estimation of the waterway with an added 129.36% streetscape inflation (Bureau of Labor

Statistics, 2014), according to the 2003 feasibility assessment, would be $12,300,000 (For a detailed analysis of this figure, refer to Table 8, columns 1). Comparatively, Paul Moosey's estimation of the waterway, with Massachusetts modern bid pricing of the streetscape, $1.9 million dollars described above, would be approximately $13,425,000. (For a detailed analysis of this figure, refer to Table 8, column 2). These total cost numbers can be seen below in Table 8, columns 1 and 2.

4) Private Contractor Pricing

For a third method to obtain modern costs for a replicated Canal, we contacted Wachusett Precast Inc. in Sterling, Massachusetts. They specialize in creating precast concrete products for contractors, homeowners, and municipalities. After providing the aforementioned dimensions associated with the replicated Canal, a representative gave us an estimate of $700 per linear foot of the replicated concrete waterway. After considering the length of the Canal and using median weighted average bid pricing for excavation costs, water costs, transportation fees, cushions (15%), planning and Engineering (2% and 10% respectively), and contingencies (15% Construction and 10% Utility), this method of assessing the cost of a replication came out to be approximately $23,300,000. This cost changed by only $20,000 when we used mean weighted average bid pricing. Both of these total costs can be seen below in Table 8, columns 3 and 4.

5) Inflation Ratio applied to 2003 Feasibility Assessment

Another method to calculate modern costs of a replicated Canal was conducted by applying an inflation ratio to the 2003 feasibility assessment "Free the Blackstone" document. When this figure is totaled through the inflation calculator from 2003 to 2014 currency prices, we calculated a value of $13,700,000 (Bureau of Labor Statistics, 2014). Using the 2% detailed master plan, 10% engineering and architecture costs, and 25% contingency from the 2003

feasibility assessment, the adjusted value was $19,200,000. The total cost of this calculation, including waterway and streetscape, can be seen in Table 8, column 5.

Using the itemized quantities from the "Free the Blackstone" feasibility assessment, and modernizing them to current pricing standards, we updated the old feasibility assessment to modern prices. For the items we could not find, we applied the 129.36% inflation figure (Bureau of Labor Statistics, 2014). Between all of the bids we used as examples, we took a mean and median value for each one of the itemized quantities. The median bid value for the entire Canal replication and streetscape was calculated to be approximately $26,000,000. The mean bid values for the entire Canal replication and streetscape was calculated to be approximately $26,000,000. These costs can be seen below in Table 8, columns 6 and 7.

All of the values discussed above are below in Table 8 to show a representation of how each value was calculated.

Table 8: Comparison using different methods to estimate replication costs

	Paul Moosey Approx. (W/ Streetscape Inflation)	Paul Moosey Approx. (W/ Modern Streetscape)	Wachusett Precast (W/ Median Modern Bid)	Wachusett Precast W/ Mean Modern Bid	Feasibility Assessment Inflation (With Inflation)	Modern Bid Pricing Updating (Median Values)	Modern Bid Pricing Updating (Mean Values)
Waterway Implementation	$7,920,000	$7,920,000	$14,282,375	$14,269,183	$10,585,005	$18,539,822	$18,526,630
Cushion	15%	15%	15%	15%			
Construction Contigency	15%	15%	15%	15%			
Utility Contingency	10%	10%	10%	10%			
Streetscaping	$776,188	$1,900,000					
Inflation					129.36%		
Detailed Master Plan			2%	2%	2%	2%	2%
Engineering / Architecture Costs			10%	10%	10%	10%	10%
Contingency					25%	25%	25%
Total	$12,297,809	$13,421,620	$23,312,113	$23,290,581	$19,204,792	$26,002,100	$25,983,600

Figure 23, below, depicts a replicated Canal drafted in AutoCAD™, which is a Computer Aided Design program. This diagram, including dimensions, were used for a quote from Wachusett Precast Inc. and the cost estimations from Paul Moosey. Moosey, claimed the dimensions of the replicated waterway that we used could be practical for the application on

Harding Street. Consideration for supporting the waterway on the sides, over soil, or directly over the cap of the existing Canal have to be considered and meet modern construction project code and standards.

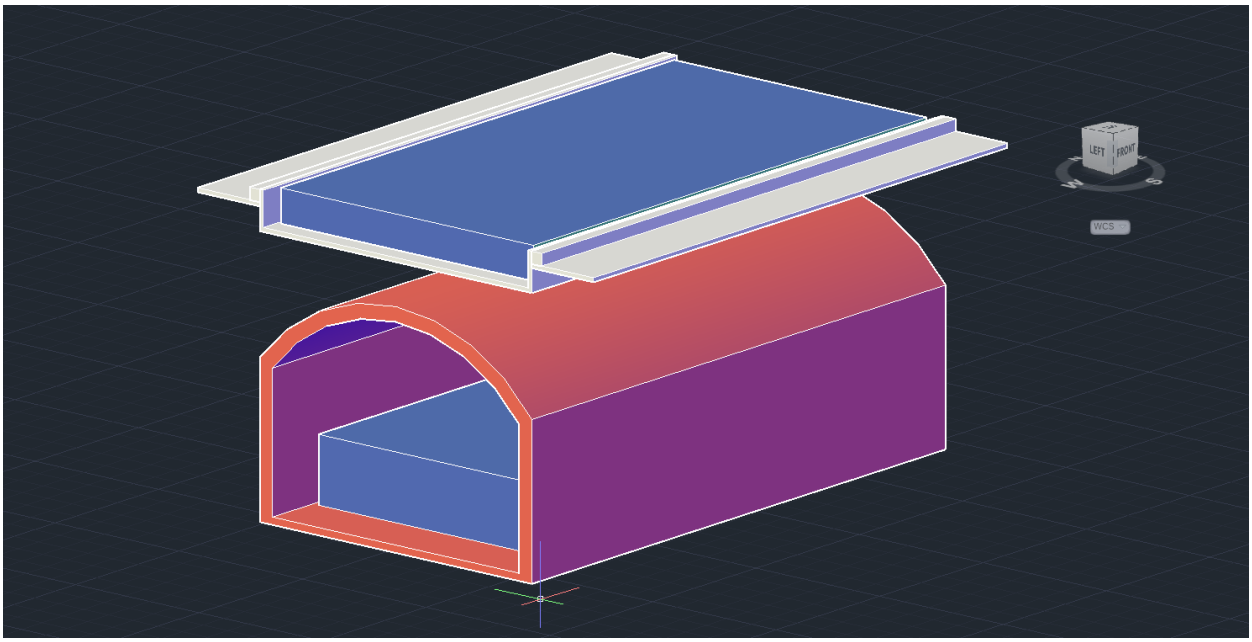


Figure 23: Isometric View of a Replicated Canal over the Existing Canal (CSO)

Calculating statistics from all of these different assessments gave us the best estimation on the potential cost of replicating the Blackstone Canal, while minimizing our percent error in each direction. This average would be one interpretation of our calculated data for the cost of replication of the Blackstone Canal. The range, mean, and median of our replication cost estimations can be seen in Table 9, below.

Table 9: Range, Mean, Median of replication cost estimation

Range	$13,704,21.47
Mean	$20,501,801.96
Median	$23,290,580.75

Our group believes that applying inflation to the 2003 feasibility assessment is a poor way to assess the cost of a replication compared to some of our other assessments. Methods such

as applying modern bid pricing are much more accurate assessments of a modern-day cost of replication. We believe that these figures are more accurate because modern big pricing closely represents the current value for that item. Considering advancements in transportation technology, manufacturing, and material science, some items and services will decrease in price with innovations in technology. Others items and services have increased in price as they are no longer standard, in limited supply, or lower demand of that item in general raises manufacturing price per unit. This should be taken into consideration when comparing the values in Table 8 above.

d. Historic significance

A replicated or restored Blackstone Canal would help promote Worcester's history as a city in the forefront of the Industrial Revolution. The Blackstone Canal was originally built as a way to facilitate a more efficient way to transport goods between Providence and Worcester. The Canal helped transform the city of Worcester from a farming community to a city at the center of the Industrial Revolution. Ranger Chuck Arning from the National Park Service believed a revitalized Canal could help paint a picture of Worcester's role in America's history for the city's residents and visitors (Arning, 2014).

As previously discussed in section VI, above, the Canal running under Harding Street is a storm water and sewer overflow storage tank. Ranger Chuck Arning and Members of the Blackstone Canal District Alliance such as Bob Largess, Eugene Zabinski, and John Giangregorio feel that the fact that the Canal can still be utilized after nearly 200 years is a testament to the advanced engineering behind Benjamin Wright's original design. Furthermore, Bill Wallace of the Worcester Historical Museum and Susan Ceccacci of Preservation Worcester believe that both a restoration and a replication, if designed correctly, would promote the

historical identity of Worcester as well as successfully depict the 19th century engineering that went into constructing the original Canal.

A replication of the Blackstone Canal rather than a restoration would not detract from the amount of visitors a revitalized Canal could expect to see. Historians and cultural experts in Worcester and the Blackstone Valley, including Susan Ceccacci, Ranger Chuck Arning, Jeannie Hebert of the Blackstone Valley Chamber of Commerce, and Bill Wallace all supported this claim. All four individuals agreed that, while a preservation of the existing Canal would be preferred, the concept of a water feature rather than the historical significance of the Canal is what would attract visitors. Furthermore, these experienced individuals agreed that using materials that would imitate the original stonework of the Canal would ensure that a replication look historically authentic. Also, these professionals agreed that small historical exhibits or features along the Canal, such as the map of the original Blackstone Canal shown in Figure 24, below could further promote the Canal's role in the Industrial Revolution.

Figure 24: Map of the Original Blackstone Canal in Worcester (photo taken 11/1/14)

e. Replication Benefits

Replicating the Canal at street level rather than restoring the Canal below street level could maximize visitor expenditures at businesses along Harding Street. Both a replication and a restoration of the Blackstone Canal would lead to an increase in visitor spending in Worcester, especially at potential retail businesses and restaurants along Harding Street. A replication in particular would maximize visitor spending along the Canal. A water feature on street level would ensure anyone walking along the Canal would be exposed to all the potential storefronts and dining options. A restored Canal would not allow for a water feature on street level. Therefore, a restored Canal could possibly limit the development of successful retail and other business along Harding Street. Retail and business development along similar restoration and replication type waterways tend to support this idea.

A Street level Canal in Worcester would most closely mimic the Bricktown Canal in Oklahoma City as the Oklahoma City Canal has businesses and storefronts along the water, seen in Figure 25 below. The comparison of the Bricktown Canal to Harding Street in Worcester, seen in Figure 26 below, shows the similarities in the surrounding buildings and potential retail and business space. In contrast, waterway restoration projects in Indianapolis and Providence

Figure 25: Bricktown Canal: Oklahoma City OK (fineartamerica.com)

Figure 26: Harding Street: Worcester, Massachusetts (Photo taken 11/1/14)

have difficulty accommodating retail and business along the Canal due to the water feature running below street level. In an interview with Martha Sheridan from the Providence Convention and Visitor Bureau, we found that this is one area where the Waterplace Park project has not reached its full potential.

Similarly, while we were not able to find an economic impact report for the Canal Walk project in Indianapolis, one web article reports that Canal Walk has not been able to reach its full potential due to the lack of business along the water ("Failure of the Canal Walk," 2009). In Worcester, the ability to build on street level would allow potential businesses along the Canal to capitalize on their waterfront appeal.

Replication would allow for more flexibility in the design and construction of both the Canal and the surrounding streetscape. A restoration and a replication of the canal would benefit the overall look and feel of the surrounding area, however a replication has the flexibility to allow for planners to get creative while having the ease of complying with current codes (Moosey, 2014). Creating a replicated Canal on top of the current Canal would also allow for the water to be at street level, allowing for easy interaction with the public as stated above. Many public officials such as Jeannie Hebert, the President of the Blackstone Valley Chamber of Commerce; Martha Sheridan, the President and CEO of the Providence Warwick Convention and Visitors Bureau, and Ranger Chuck Arning with the National Park Service feel that the appeal of up close interaction with the water would favor a replication over a restoration.

Replication of the Canal allows for different options in the design of the Canal, whereas a restoration of the Canal would be limited to its current infrastructure. Building a new Canal would also be a safer alternative to the current Canal. With the Canal being on street level with approximately three feet of water, the safety regulations would be much less compared to the

current Canal that could potentially be 15-20 feet below street level according to professionals such as Paul Moosey, Department of Public Works Commissioner.

A replication will cost less and yield more benefits than a restoration of the Blackstone Canal, making it a more beneficial revitalization option for the city of Worcester. Based on our research, we find that a replication of the Blackstone Canal on Harding Street would be a more feasible option for the city of Worcester. The construction costs associated with restoring the Canal would be significantly higher than a replication because the CSO system would need to be rerouted. Furthermore, most of the benefits in other cities that showed the potential for Worcester did not differ based on whether the project was a restoration or a new construction project. Also, a replication has environmental and implementation benefits that a restoration would not have. Even though daylighting the Canal would be more authentic, the overwhelming cost of a restoration and the similar benefits both a restoration and replication would have make the replication a better investment for the city of Worcester.

III. Recommendations

In the following sections, we make recommendations to the Blackstone Canal District Alliance and the city of Worcester based on our various findings. These recommendations focus on further research we feel would advance the process of implementing a replicated Blackstone Canal on Harding Street in Worcester.

a. Recommendation 1: Assess feasibility of CSO rerouting

The Combined Sewer Overflow that the Canal is being used for is a very intricate system. Paul Moosey, Commissioner of the Worcester Department of Public Works, and Al Charbonneau, former Sewer Pumps Stations Supervisor in Worcester, expressed concerns with

rerouting of the CSO system. The main concern both individuals had was the challenge of building a new storage tank of the same size and in the same area that would continue to help the wastewater treatment plant treat the necessary amount of water to meet USEPA standards. Worcester Polytechnic Institute will have a group of students assess the feasibility of rerouting the Combined Sewer Overflow system in early 2015.

b. Recommendation 2: Establish one vision and design for the Blackstone Canal replication

Our interviewees have expressed several different opinions and ideas on how to revitalize the Blackstone Canal along Harding Street in Worcester. Options included day-lighting the Canal, constructing a new waterway on top of the existing Canal, constructing a new waterway to the side of the existing Canal, and continuing to use half of the existing Canal as a CSO tank and half as the waterway. We were also asked how a waterway would affect the streets crossing Harding Street, such as Winter Street and Harrison Street. Furthermore, a recurring question we were asked was if the Canal would be a strictly pedestrian area or if there would continue to be traffic alongside the waterway.

Establishing one vision for the design of the revitalized Blackstone Canal would catalyze more focused discussion on the implementation of the waterway. Professionals would be able to give a better estimate of the cost of revitalizing the Blackstone Canal if one vision was proposed rather than several different ideas. Furthermore, the economic impact of a revitalized Canal could be analyzed in more detail if professionals had one vision to assess. Therefore, we recommend the Blackstone Canal District Alliance propose a replicated Blackstone Canal in the future. Furthermore, we recommend a singular engineering design be created for the replication of the Canal so that costs and economic benefits can be analyzed in greater detail.

c. Recommendation 3: Assess community and business support

Multiple interviews with political decision makers on the local, state, and federal level determined that local community and business support for revitalizing the Canal should be analyzed to advance implementation of the Blackstone Canal replication in Worcester. Surveying of Worcester residents and residents of surrounding towns can help prove that a revitalized Blackstone Canal would attract visitors and tourists. Furthermore, business owners on Harding Street and other adjacent streets may be concerned with how a Blackstone Canal revitalization will affect their business for the duration of construction or conversely may be supportive of the potential for increased patronage. Community and business support would help the Blackstone Canal District Alliance promote their vision for a revitalized Blackstone Canal.

Conclusion

The Blackstone Canal District Alliance tasked us with conducting a cost and benefit analysis of revitalizing the Blackstone Canal in Worcester, Massachusetts. Economic, social, and historic impact information gathered from other cities that have conducted waterway revitalization and construction projects show the potential impact a revitalized Blackstone Canal would have in Worcester. We analyzed other cities for increased tourism, increased private investment, increased property values, increased property tax revenues, increased quality of life, and increased aesthetic appeal for the buildings that line Harding Street in Worcester.

Based on information gathered from Department of Public Works professionals and the National Park Service we concluded that since the Blackstone Canal is utilized as Combined Sewer Overflow system, a replication of the Canal would be a more beneficial option to pursue. This conclusion was based not only on large cost of rerouting the CSO but also the fact that other similar waterway revitalization projects showed that the benefits of a restoration and a replication are similar. Furthermore, replication would allow for a street level water feature with greater design flexibility.

Lastly, our group recommends that further research be conducted to further analyze the CSO system as well as community and business support. Also, we recommended that one vision and design of the Canal should be established so that more focused discussion among decision makers could begin. Based on the success of similar waterway revitalization and construction projects, a Blackstone Canal revitalization would bring economic, social, and historic benefits to the city of Worcester, its residents, its employees, and visitors.

References

Abstracts of Papers Presented at the Annual Meeting
The Journal of Economic History, Vol. 61, No. 2 (Jun., 2001), pp. 517-531
Published by: Cambridge University Press on behalf of the Economic History Association
Article Stable URL: http://www.jstor.org/stable/2698038

Bird, W. (2014). Worcester Councilor Phil Palmieri announces state rep run against Mary Keefe Worcester Mag.

Blackstone Canal District designated. (2002, 05/02/2002 May 02). *Telegram & Gazette*, pp. 0-B4. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/268832759?accountid=29120Retrieved

Boyle, K. The Ruins of Detroit: Exploring the Urban Crisis in the Motor City. *JSTOR*. Retrieved September 28, 2014, from http://www.jstor.org/stable/20173897

Breger, G.. The Concept and Causes of Urban Blight. JSTOR. Retrieved October 13, 2014, from http://www.jstor.org/stable/3145542

Brustlin, V. H. (2011, November 5). Blackstone River Valley National Heritage Corridor Commission Blackstone Canal Alternative Transportation Feasibility Study Lincoln, RI. *National Park Service*. Retrieved September 21, 2014, from http://www.nps.gov/blac/parkmgmt/upload/Canal-Feasibility-Study-RI-FINAL-DRAFT-Dec-2011.pdf

Canal Vision; Study aids debate on Blackstone development plan. (2002, 10/20/2002 Oct 20). *Telegram & Gazette*, pp. 0-C1. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/268860740?accountid=29120Retrieved

The Capital Center Project. (n.d.). Retrieved December 1, 2014, from http://www.marselladevelopment.com/bld_publi

Carpenter, T. (2014). City of Oklahoma City - Metropolitan Area Projects. Retrieved November 30, 2014, from http://www.brownfieldrenewal.com/renewal-award-project-economic_impact-city_of_oklahoma_city___metropolitan_area_projects-1.html

Cobb, B. (2014, November 5). Canal Water Taxi Tour Oklahoma City. Retrieved November 10, 2014, from http://fineartamerica.com/featured/canal-water-taxi-tour-oklahoma-city-bill-cobb.html

Combined Sewer Overflows (CSO) Home. (2014, November 24). Retrieved December 10, 2014, from http://water.epa.gov/polwaste/npdes/cso/

Davies, Anne. Car industry crisis takes toll in Motown; Fallout starts to spread across US in wake of Chrysler bankruptcy. (2009) (pp. NEWS; International News; Pg. 13).

Davis, Marion.-B. S. (1997). Global Conference draws over 150 delegates Canal visitors awash in local lore Officials of British Waterways say restoration of the Blackstone Canal would be a relatively easy task - "a matter of tidying up" - and well worth the effort. *Providence Journal - Bulletin*, C.01.

Detroit's Beautiful, Horrible Decline - Photo Essays. Time. Retrieved October 12, 2014, from http://content.time.com/time/photogallery

Detroit's Fight Against Blight. (2014, June 7). The New York Times. Retrieved October 13, 2014, from http://www.nytimes.com/2014/06/08/opinion/sunday/detroits-fight-against-blight.html

Dickson, B. H. (1968). COMPARISON OF THE BLACKSTONE AND MIDDLESEX CANALS. *Old-Time New England, 58*(4), 89-98.

Donahue, J. (2009, May 5). Worcester. Urban Decay, a photo from Massachusetts, Northeast. Retrieved October 13, 2014, from http://www.trekearth.com/gallery/North_America/United_States/Northeast/Massachusetts/Worcester/photo1074437.htm

Doyle, B. (2014, November 7). Visitor Guide and Directory Map of Downtown Providence. Retrieved November 10, 2014, from http://www.providenceri.com/directions/pedc-map/pedc-map-nav.html

Eckelbecker, L. (2014, 09/07/2014 Sep 07). Canalfest makes a splash. *Telegram & Gazette*. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/1560415720?accountid=29120Retrieved

Eichengreen, B. Viewpoint: Understanding the Great Depression. JSTOR. Retrieved October 13, 2014, from http://www.jstor.org/stable/3696096

Fairchild, P. (2010, March 1). BRICKTOWN: The Past, Present and Future of Oklahoma City. Retrieved November 15, 2014.

Farbstein, J. (2004). Providence River Relocation. Retrieved December 6, 2014, from http://www.brunerfoundation.org/rba/pdfs/2003/

Free the Blackstone! Blackstone Tap. Retrieved October 12, 2014, from http://blackstonetap.com/

Gahl, C. (2014, November 10). Official Tourism Site of Indianapolis | Visit Indy. Retrieved November 14, 2014, from http://visitindy.com/indianapolis-about-visit-indy-contact http://visitindy.com/indianapolis-about-visit-indy-contact

Gordon, C. (2003). Blighting the way: Urban renewal, economic development, and the elusive definition of blight. *Fordham Urb. LJ*, *31*, 305.

Greasley, D., & Madsen, J. Investment and Uncertainty: Precipitating the Great Depression in the United States. *JSTOR*. Retrieved September 28, 2014, from http://www.jstor.org/stable/3874075

Greenwood, R. (2006). WHM- Blackstone Canal- History of the Canal. from http://www.worcesterhistory.org/bcinfo/bcinfo-home.html

Groberg, R. P. (1965). Urban Renewal Realistically Reappraised. *Law and Contemporary Problems*, *30*(1), 212-229. doi: 10.2307/1190695

Halloran, D. Progress against Poverty: The Governmental Approach. *JSTOR*. Retrieved September 29, 2014, from http://www.jstor.org/stable/974121

Hanh, V. T. H. (2006). Canal-side highway in Ho Chi Minh City (HCMC), Vietnam – Issues of urban cultural conservation and tourism development. *GeoJournal*, *66*(3), 165-186. doi: 10.2307/41148077

Indy: The Failure of the Canal Walk. (2009, September 13). Retrieved November 20, 2014.

Inflation-calculator. *davemanuel.com/inflation-calculator*. Retrieved October 7, 1014, from http://www.davemanuel.com/inflhttp://www.davemanuel.com/inflation-calculator.phpation-calculator.php

Johnston, B. (2005, Apr 01). Waterway benefits realised. Planning, , 15. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/229896506?accountid=29120

Kotsopoulos, N. (2014, 09/10/2014 Sep 10). Keefe wins in the 15th. *Telegram & Gazette*. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/1560927986?accountid=29120Retrieved

Lackmeyer, S. (2009, June 28). Bricktown Canal to celebrate 10th anniversary. Retrieved December 1, 2014, from http://newsok.com/bricktown-canal-to-celebrate-10th-anniversary/article/3381297#http://newsok.com/bricktown-canal-to-celebrate-10th-anniversary/article/3381297

Magiera, M. A., Telegram, & Gazette, S. (1999, 02/22/1999 Feb 22). In search of the Blackstone Canal. *Telegram & Gazette*, pp. 0-A1. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/268717465?accountid=29120Retrieved

Mayer, H. The Chicago and North Western Railway. Railroads. Retrieved October 13, 2014, from http://www.encyclopedia.chicagohistory.org/pages/1039.html

Menkhaus, D., Bastian, C., Phillips, O., & O'Neill, P. Endogenous Choice of Institution Under Supply and Demand Risks in Laboratory Forward and Spot Markets. *JSTOR*. Retrieved September 28, 2014, from http://www.jstor.org/stable/40987038

Miller, E., & Miller, S. (2014, November 30). "Out and About" Images. Retrieved December 10, 2014, from http://oklahomablogger.com/some-of-our-photos/

Mitchell, B. C. (1982). Interpreting American Industrial History: The Lowell National Historical Park's General Management Plan: An Overview. *International Labor and Working-Class History*(21), 69-72. doi: 10.2307/27671399

Monahan, J. J. (2000, 08/10/2000 Aug 10). Blackstone Canal funds may flow into Worcester. *Telegram & Gazette*, pp. 0-B1. Retrieved from http://ezproxy.wpi.edu/login?url=http://search.proquest.com/docview/268778129?accountid=29120Retrieved

Nicholson, L. K. (2002). Discover Providence: Providence: Experience the Viberancy of Revitalized Capital City. *History News, 57*(4), 26-27. doi: 10.2307/42653881

Olney, M. Avoiding Default: The Role of Credit in the Consumption Collapse of 1930. JSTOR. Retrieved October 13, 2014, from http://www.jstor.org/stable/2586955

Providence-Warwick, RI CVB. (2014, August 18). Retrieved November 3, 2014, from http://www.strglobal.com/Media/Default/Documents/DataReportingGuidelines/STR_STRGlobal_Data_Guidelines_2015.pdf

Rowthorn, R., & Ramaswamy, R. Growth, Trade, and Deindustrialization. *JSTOR*. Retrieved September 28, 2014, from http://www.jstor.org/stable/10.2307/3867633

Research Department of the U.S. Travel Association. The Economic Impact of Travel on Massachusetts Counties 2010, Washington D.C.

Reynolds, D. (1991). SHIP'S CAPTAIN, SHOP'S COTTON: WILBER KELLY AND EARLY AMERICAN INDUSTRIALIZATION. *Rhode Island History, 49*(2), 37-49.

Rosenfeld, M. Young Adulthood as a Factor in Social Change in the United States. JSTOR. Retrieved October 13, 2014, from http://www.jstor.org/stable/20058850

Sachs, Jeffrey D., and Howard J. Shatz, 1994, "Trade and Jobs in U.S. Manufacturing," Brookings Papers on Economic Activity: 1, Brookings institution

Smith, B. (1995, February 26). Texas Two-Step Promenading around the Alamo, the Riverwalk and Other Sights of San Antonio. Questia. Retrieved October 13, 2014, from http://www.questia.com/newspaper/1P2-32924667/texas-two-step-promenading-around-the-alamo-the-riverwalk

Stock Market Crash. PBS. Retrieved October 13, 2014, from http://www.pbs.org/fmc/timeline/estockmktcrash.htm

Sullivan, Margo. Douglas St. eyesore typical urban blight Douglas St. eyesore typical urban bli. (2000).

Tertius, C. Four Thousand Years of Urban Growth: An Historical Census. St. David's University Press. Retrieved October 14, 2014, from http://geography.about.com/library/weekly/aa011201f.htm

Tinerella, V. The Industrial Revolution in America: Iron and Steel, Railroads, Steam Shipping. Industrial Revolution in America. JSTOR. Retrieved October 13, 2014, from http://www.jstor.org/stable/20864495

Vanstone, J. The Ainu Group at the Louisiana Purchase Exposition, 1904. *JSTOR*. Retrieved October 7, 2014, from http://www.jstor.org/stable/40316339

Warner, L. (2009). Impact Analysis of Oklahoma City's MAPS and other Significant Central City Investments. Retrieved November 30, 2014.

Waterplace Park — Providence, Rhode Island. (2008). from https://www.planning.org/greatplaces/spaces/2008/waterplacepark.htm

Wayne, K. A Polynomial Combinatorial Algorithm for Generalized Minimum Cost Flow. *JSTOR*. Retrieved October 7, 2014, from http://www.jstor.org/stable/3690445

Wilson, R. A., Jr. (2000). THE BLACKSTONE CANAL. *Historical Journal of Massachusetts, 28*(1), 76-97.

Appendices

Appendix A: Knowledgeable Person Interview Template

We are a group of students from Worcester Polytechnic Institute in Massachusetts working in conjunction with the Blackstone Canal District Alliance. We are conducting interviews on background information for the efforts of the Blackstone Canal District Alliance and their goal to revitalize the Blackstone Canal. We strongly believe this kind of research will aid the quality of life for Worcester and its residents.

Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous if preferred.

This is a collaborative project between Blackstone Canal District Alliance and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

- Are you aware of the Blackstone Canal District Alliance's vision for a Blackstone Canal Revitalization?
    - If so, what are your thoughts
- Do you have any experience with a restoration of a waterway?
- What kinds of unforeseen obstacles could be faced when doing the replication or restoration?
- Do you think this kind of project could be beneficial to the city of Worcester?
- Do you have any rough estimates for time or costs of either project?
- Do you think one of these project ideas will be successful?
    - Why or why not?

Additional Questions for Professionals of Similar Projects

- What was the overall cost of your revitalization project?
- What were some unforeseen costs of your project?
- What are some of the financial benefits that have resulted from the project?
- What are some of the social benefits that have resulted from the project?
- What are some of the cultural benefits that have resulted from the project?
- Specifically, do you have statistics on increased tourism, business creation, tax revenue, etc.?
- What were some roadblocks associated with your project?
- Do you mind if we contact you with any additional questions that may arise?

Appendix B: Politician Interview Template

We are a group of students from Worcester Polytechnic Institute in Massachusetts working in conjunction with the Blackstone Canal District Alliance. We are conducting interviews on background information for the efforts of the Blackstone Canal District Alliance and their goal to revitalize the Blackstone Canal. We strongly believe this kind of research will aid the quality of life for Worcester and its residents.

Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous if preferred.

This is a collaborative project between Blackstone Canal District Alliance and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

- Are you aware of the Blackstone Canal District Alliance's vision for a Blackstone Canal Revitalization?
    - If so, what are your thoughts
- Do you support this kind of project? Why or why not?
- Do you think state or government funding would allotted for either project?
- What potential roadblocks could you see interfering with these projects?
- What kind of support would be required to allow for these projects to commence?
- What advantages or disadvantages could you see for a restoration?
- What advantages or disadvantages could you see for a replication?
- Do you think this kind of project could be beneficial to the city of Worcester?
- Do you think one of these project ideas will be successful?
    - Why or why not?

Appendix C: Historian Interview Template

We are a group of students from Worcester Polytechnic Institute in Massachusetts working in conjunction with the Blackstone Canal District Alliance. We are conducting interviews on background information for the efforts of the Blackstone Canal District Alliance and their goal to revitalize the Blackstone Canal. We strongly believe this kind of research will aid the quality of life for Worcester and its residents.

Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous if preferred.

This is a collaborative project between Blackstone Canal District Alliance and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

- Are you aware of the Blackstone Canal District Alliance's vision for a Blackstone Canal Revitalization?

The Blackstone Canal District Alliance wants to improve the economic, social, and cultural identity of Worcester through the restoration or replication of the Blackstone Canal. A restoration would involve the digging up of the underground Canal and using it as the centerpiece for a multi-use destination neighborhood. A replication would involve creating a small-scale version of the Canal instead.

- Do you feel the history surrounding the Blackstone Canal is significant enough to attract tourism and new businesses to the city of Worcester?
- Do you feel a replication rather than a restoration will take away from the historical significance of this project?
- What do you feel are the most important historical aspects that need to be portrayed by this project?
- What advantages or disadvantages could you see for a restoration?
- What advantages or disadvantages could you see for a replication?

Appendix D: Interviewees

Canal District Alliance	Position
John Giangregorio	President
Scott Fair	Member
Eugene Zabinski	Treasurer
JeanPaul Raymond	Member
Bill Chase	Member
Paul Foley	Member
Allen Fletcher	Former President Current Member

State Representatives	Position
Jim McGovern	Congressman
Harriette Chandler	State Senator
Mary Keefe	State Representative
Dan Donahue	State Representative
Tim Murray	Former Lieutenant Governor and Mayor of Worcester Current President and CEO of CoC
Karen Pelletier	CoC Director of Higher Education

DPW Members	Position
Paul Moosey	Commissioner
Matt Crocker	Engineering
Al Charbonneau	Retired Sewer Pumps Stations Supervisor
James Okerberg	Asst. Chief Pumping Station Operator
Chris Gagne	Civil Engineer

National Park Representatives	Position
Chuck Arning	Ranger

Blackstone Valley Chamber of Commerce	Position
Jeannie Heber	President

Worcester Historical Museum	Position
Bill Wallace	Executive Director

Central Mass Visitor and Convention Bureau	Position
Donna McCabe	President

Providence Warwick Convention and Visitors Bureau	Position
Martha Sheridan	President and CEO

Narragansett Bay Commission	Position
Pamela Reitsma	Environmental Scientist

Worcester City Hall	Position
Edward Augustus	City Manager
Phil Niddrie	Economic Development
William Ford	City Assessor
Peter Dunn	Business Programs Manager Division of Business Assistance
Erin Williams	Cultural Development Officer

The Williams Group Real Estate Advisors	Position
David Williams	Principal in Charge
Susan Olivier	Senior Economic Planner

Rhode Island Department of Transportation	Position
Mel DiPaolo	Plan Room Geographic Information Systems Specialist
Nathan Shapiro	Business Management Officer

Preservation Worcester	Position
Susan Ceccacci	Education Director

Oaktown Downtown Oklahoma City Inc.	Position
Mallory O'neill	Bricktown District Manager

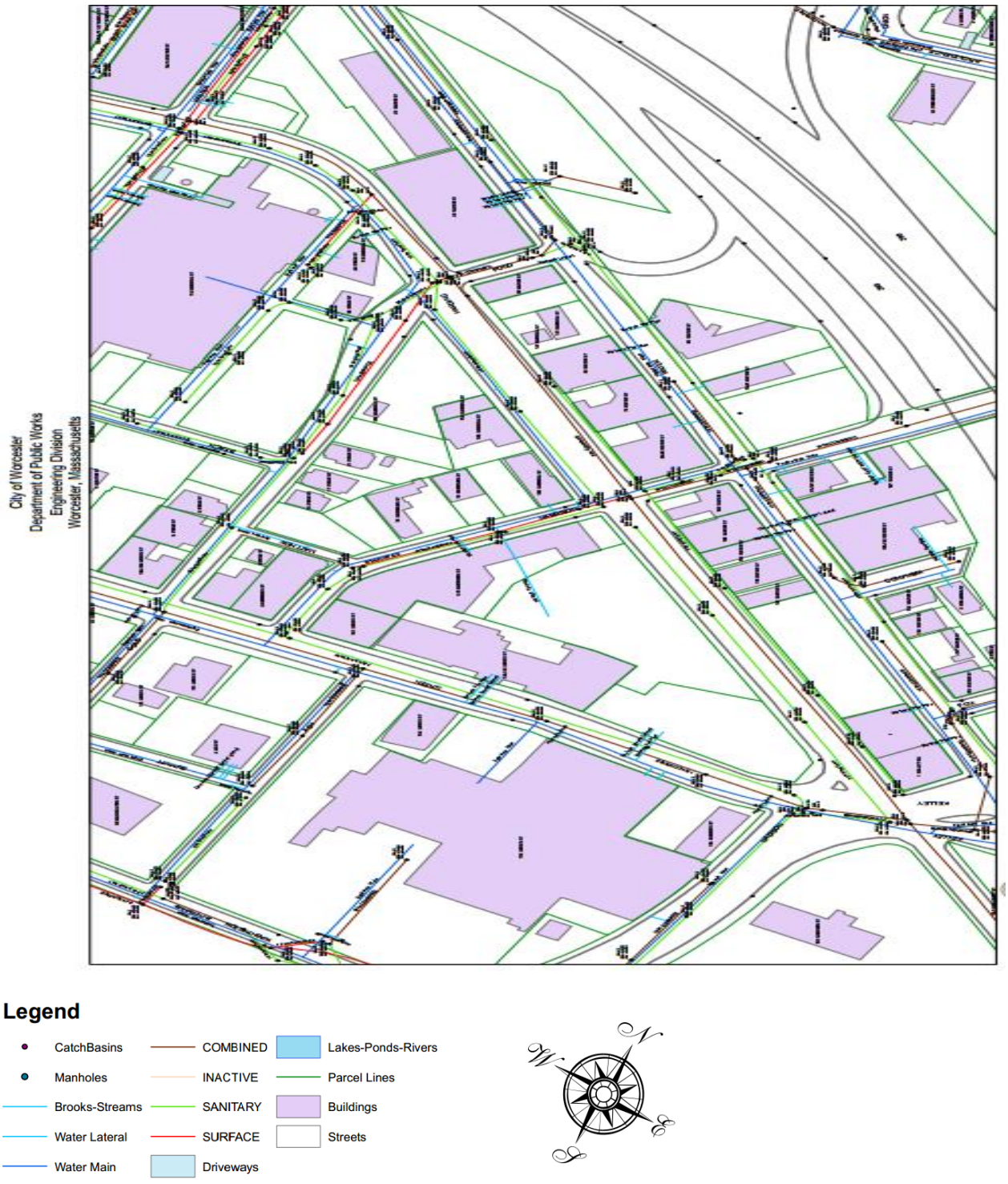
DEP Worcester	Position
Denise Child	Regional Enforcement Coordinator

Lowell National Park	Position
Cara Liassom	N/A

MASSDOT	Position
Susan Rettucci	Planning Department

Worcester Research Bureau	**Position**
Timothy McGourthy	Executive Director

Appendix E: Geographic Information System Diagram of Harding Street, Worcester, Massachusetts (Charbonneau, 2014)



Appendix F: 32 Pump Stations in Worcester, Massachusetts (Charbonneau, 2014)

Pump Station	Address	Phone #	Alarm Code	Dry Weather Flow	Unit
Arietta Pump Station	20 Arietta St. (MH Type)	(508) 752 - 1064	7#	65,000	GPD
Botany Bay Pump Station	2 Botany Bay Rd. (MH Type)	(508) 798 - 8223	555	22,500	GPD
Bridle Path Pump Station	331 Bridle Path	(508) 752 - 1432	7#	24,800	GPD
Broadmeadow Brook Pump Station	318 South West CutOff (RT 20)	(508) 793 - 0839	7#	322,300	GPD
Brookhaven Pump Station	66 Brookhaven Rd. (MH Type)	(508) 852 - 8309	7#	21,670	GPD
Cambridge St. Pump Station	642 Cambridge St.		7#	SURFACE WATER	
Central St. Pump Station	86 Central St. (MH Type)	(508) 284 - 3862	7#	SURFACE WATER	
Crowningshield Pump Station	62 Crowningshield Rd. (MH Type)	(508) 757 - 3458	555	46,600	GPD
Dunkirk Pump Station	70 Dunkirk Ave.	(508) 752 - 6952	7#	1,793,000	GPD
Grafton St. Pump Station	1365 Grafton St.	(508) 754 - 0317	7#	2,300	GPD
Greenwood St. Pump Station	345 Greenwood St.	(508) 799 - 9515	7#	362,080	GPD
Hemlock St. Pump Station	2 Hemlock St. (MH Type)	(508) 792 - 1087	7#	5,300	GPD
Holden St. Pump Station	78 Holden St.	(508) 853 - 3589	7#	370,800	GPD
James St. Pump Station	236 James St. (MH Type)	(508) 757 - 3339	7#	2,440	GPD
Kettle Brook Pump Station	1507 Main St.	(508) 799 - 3707	555	8,200	GPD
Lake Ave. Pump Station	85 Lake Ave.	(508) 752 - 7805	(508) 752 - 6022 / 7	3,990,000	GPD
Lincoln Sq. Tunnel Pump Station	Lincoln Sq. Johnson Tunnel		7#	???	
Livermore Pump Station	2A Livermore St. (MH Type)	(508) 852 - 8283	555	14,000	GPD
Millbury St. Pump Station	1070 Millbury St.	(508) 792 - 3215	7#	194,000	GPD
Millbury II Pump Station	1152 Millbury St.	(508) 799 - 8321	7#	???	
Oakbeach Pump Station	7 Oakbeach Terr. (MH Type)	(508) 799 - 1534	7#	9,900	GPD
Pineland Pump Station	26 Pineland Ave. (MH Type)	(508) 753 - 2020	7#	62,000	GPD
Proctor St. Pump Station	11 Proctor St.	(508) 799 - 1536	7#	37,200	GPD
Quinsigamond Pump Station	60 Quinsigamond Ave.	(508) 754 - 5478	(508) 755 - 3039 / 7	200,000	GPD
Sears Island Pump Station	1 Sears Island Dr. (MH Type)	(508) 853 - 5978	7#	24,040	GPD
Shrewsbury Pump Station	215 Shresbury St. (MH Type)	(508) 795 - 1056	555	75,000	GPD
Suntaug Rd. Pump Station	15 Suntaug Rd. (MH Type)	(508) 799 - 1537	7#	14,800	GPD
Waller Ave. Pump Station	1 Waller Ave. (Lift Station	(508) 799 - 1003	7#	1,902	GPD
Webster St. Pump Station	224 Webster St.	(508) 753 - 1143	7#	258,900	GPD
Whitla Dr. Pump Station	39 Whitla Dr.	(508) 798 - 6750	7#	658,000	GPD
Whitla II Pump Station	39 Whitla Dr. (MH Type)		7#	2,400	GPD
Upper Blackstone Pump Station	Upper Blackstone De-Water		7#	???	

Total:	8,589,132

Appendix G: Mean and Median Average Bid Prices (massdot.com, 2014)

Section	Item	Unit	Quatity	WAUP Median or Inflated LS Price	WAUP Mean or Inflated LS Price	Median Total	Mean total
1.01	Site Prep/Utilities						
	crushed stone	CY	620	65.00	76.67	40300	47535.4
	class b trench excavation	CY	4790	26.00	26.83	124540	128515.7
	water crossings (8"-24") (removed and relayed)	LF	900	38.8094022	38.8094022	34928.46198	34928.46198
	sewer crossings (removed and relayed)	LF	1200	68.56327722	68.56327722	82275.93266	82275.93266
	electrical crossings (removed and relayed)	LF	300	6.4682337	6.4682337	1940.47011	1940.47011
	gas crossings (removed and relayed)	LF	300	25.8729348	25.8729348	7761.88044	7761.88044
1.02	Canal way / Fenway						
	Water Way (Base, Bottom, Sides)	SF	137760	45.2776359	45.2776359	6237447.122	6237447.122
	Cap	SF	2850	64.682337	64.682337	184344.6605	184344.6605
1.03	Water Node Upgrades						
	Union station turning basin	LS	1	64682.337	64682.337	64682.337	64682.337
	Market Place Basin	LS	1	64682.337	64682.337	64682.337	64682.337
	Crompton Looms Workplace Basin	LS	1	64682.337	64682.337	64682.337	64682.337
	Lock 48 Restoration	LS	1	97023.5055	97023.5055	97023.5055	97023.5055
1.04	System Hydraulics						
	Subsurface Storage Tank	EA	2	988346.1094	988346.1094	1976692.219	1976692.219
	Stormwater Pumps (2000GPM)	EA	9	12936.4674	12936.4674	116428.2066	116428.2066
	Recirculating Pumping System	LS	1	129364.674	129364.674	129364.674	129364.674
	Piping	LS	1	129364.674	129364.674	129364.674	129364.674
3.01	Site Prep/Utilities						
	Unclassified Excavation	CY	10630	26.00	25.31	276380	269045.3
	Pavement Excavation	SY	12750	15.00	13.60	191250	173400
	Class I Bituminous concrete pavement	TON	380	98.31715224	98.31715224	37360.51785	37360.51785
	Bitumen for Tack Coat	GAL	30	8.38	8.42	251.4	252.6
	Sawcutting BIT Concrete (at ends of excavation)	LF	30	1.29364674	1.29364674	38.8094022	38.8094022
	Traffic and Street Sign (removed and Reset)	EA	40	100.00	97.43	4000	3897.2
	Police Detail	LS	1	388094.022	388094.022	388094.022	388094.022
3.02	specialty Pavement Roadways and sidewalks						
	38' Width (w/Brk. Sidewalk & cobbles)	LF	2000	937.8938865	937.8938865	1875787.773	1875787.773
3.03	Brideges and culverts						
	Brideges (traffic) (30'LX40'W)	EA	3	970235.055	970235.055	2910705.165	2910705.165
	Bridges (pedestrian) (30'LX12'W)	EA	4	258729.348	258729.348	1034917.392	1034917.392
3.05	Misc Roadway & Traffic Signal Infrastructure	LS	1	517458.696	517458.696	517458.696	517458.696
3.06/4.01	Streetscaping and Sector Streetscaping						
	Street Trees	EA	250	532.00	572.33	133000	143082.5
	Lighting and Banners	EA	110	10000	10000	1100000	1100000
	Interpretive Exhibits	EA	12	6468.2337	6468.2337	77618.8044	77618.8044
	Bollards	EA	80	850.00	880.65	68000	70452
	Lawns/Shrubs	EA	10000	47.00	45.79	470000	457900
	Benches/Trash bins/Moisc	EA	50	1970.00	1978.98	98500	98949
					Totals	18539821.4	18526629.7